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BUREAU OF SHIPS GROUP
TECHNICAL INSPECTION REPORT

Classification ~~(Cancelled)~~ (Changed to CONFIDENTIAL
By Authority of Joint Chiefs of Staff (Action 15 Apr 49)
By John Begg Capt Date 1 May 51

(6) OPERATION CROSSROADS.

U.S.S. LCT's 705,816,818,874,1013, 1078,1112,1113

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TEST ABLE (U)

(11) 1947,
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~~OPERATION CROSSROADS~~

(14) XRD-80

~~DIRECTOR OF SHIP MATERIAL~~

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BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

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Captain, U.S.N.

USS LCT's 705, 816, 818, 874
1013, 1078, 1112, 1113

Page 1 of 146 Pages

[redacted]

GROUP-3 1 JAN 1965
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BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

No damage.

(c) Other damage.

None.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

None, as far as can be determined from visual inspection.

(b) Effect on gunnery and fire control.

Gunnery and fire control were unaffected electrically.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

The distance of this vessel from the blast was too great for damage to occur.

V. Preliminary Recommendations.

None.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

No damage.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

No comment.

V. Recommendations.

None.

VI. Instructions for Loading the Vessel Specified the Following:

ITEM	LOADING
Diesel oil	Minimum

ITEM	LOADING
Ammunition Potable and reserve feed water Salt water ballast	No special adjustment required.

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships' Crossroads Files.

DETAILED DESCRIPTION OF HULL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

There was no damage.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

No comment.

(b) Structural damage.

No comment.

(c) Other damage.

None, as far as can be determined by visual inspection.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence on machinery of this vessel.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

No evidence.

III. Effects of Damage.

(a) Effects on machinery and ship control.

None, as far as can be determined by visual inspection. No machinery was operated or tested after Test "A".

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on water tight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

None.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

The ship sustained no damage whatsoever. It was outside the effective range of the explosion in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Machinery Damage.

(a) Overall condition.

Test "A" had no effect on the machinery of this vessel. As far as could be determined by visual inspection, there was no damage.

(b) Areas of major damage.

None.

(c) Primary cause of damage.

None.

(d) Effect of target test on overall operation of the Machinery plant.

The operability of the machinery plant was not effected by the target test as far as could be determined by visual inspection.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Drafts and list were not observed. There was no flooding.

(b) Structural damage.

No structural damage observed which affected electrical equipment.

(c) Other damage.

No electrical damage occurred as a result of test "B".

II. Forces Evidenced and Effects Noted.

(a) Heat.

There was no evidence of heat.

(b) Fires and explosions.

There was no evidence of fires or explosions.

(c) Shock.

There was no evidence of shock to electrical equipment.

(d) Pressure.

There was no evidence of pressure on electrical equipment.

(e) Any effects apparently peculiar to the Atom Bomb.

There were no effects noted that are considered peculiar to the Atomic Bomb other than radioactivity.

III. Effects of Damage.

(a) Effect on electrical equipment and ship control.

Although operability tests were not conducted, all electrical equipment and ship control were apparently unaffected by this test.

(b) Effect on gunnery and fire control.

Gunnery and fire control were unaffected electrically.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

It is considered the only effect on personnel and habitability would have been that due to radioactivity.

(e) Total effect on fighting efficiency.

There was no effect on the fighting efficiency of this vessel as a result of test "B" from electrical failures. It is considered that except for possible personnel casualties due to radioactivity this vessel's fighting efficiency would have been unimpaired.

IV. General Summary of Observers' Impressions and Conclusions.

The distance of this vessel from the blast was too great for electrical damage to occur.

V. Any Preliminary General or Specific Recommendations of the Inspection Group.

None.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

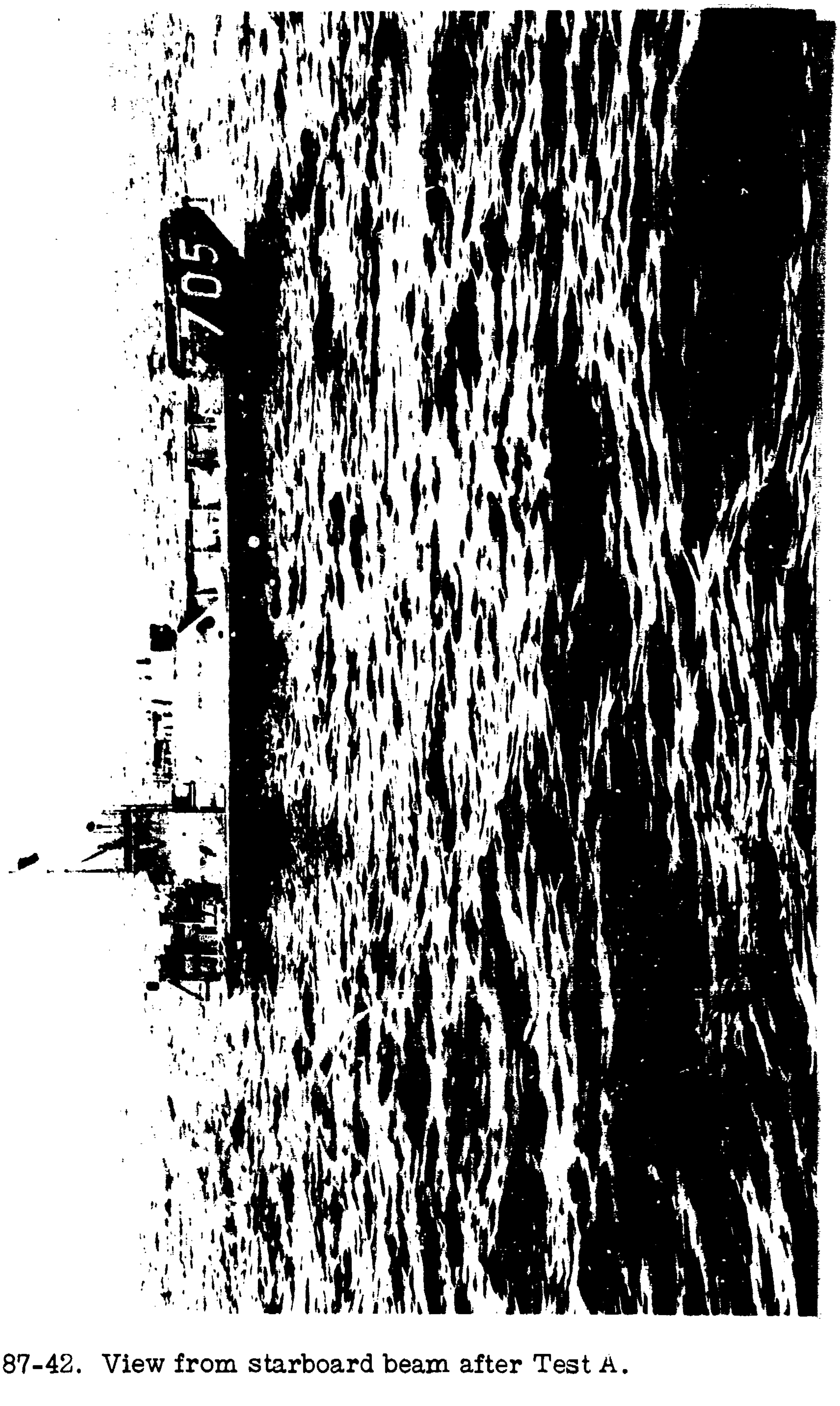
NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

There was no damage.

APPENDIX

PHOTOGRAPHS

TEST ABLE



AA-CR-227-87-42. View from starboard beam after Test A.

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test, general areas of flooding, sources.

There was no flooding, hence no change in drafts or list. There was a samll amount of minor seepage through the steam tubes

(b) Structural Damage.

Damage to this craft consists of dishing of bulkheads exposed to the blast and moderate fire damage. The mast caught fire, burned through about three feet below the yardarm, and felldown alongside the pilot house.

(c) Other Damage.

There was no crew aboard and no power available for operating machinery. However, except for two shattered light bulbs and the damage caused by the fire, the electrical and machinery equipment suffered no apparent damage. The exhaust fan in the galley overhead, a blower motor for the galley range and one galley light were inoperable due to damage to their cables from the heat of the fire.

II. Forces evidenced and effects noted.

(a) Heat.

Heat scorched paint to a depth of one coat and blistered vertical surfaces facing aft. Lines were scorched.

(b) Fires and Explosions.

The wooden mast is almost completely burned off just below the yardarm. A fire on the port quarter burned the contents of some open cans of paint, a wooden plank, and some cable insulation. This fire warped a section of the after bulkhead of the galley and caused severe scorching of paint in the galley.

(c) Shock.

None.

(d) Pressure.

Damage due to blast is confined to the slight dishing of exposed bulkheads and the severe distortion of the angle framing of the flagbag. The critical weight of plating appears to be 10# M.S.

(e) Effects peculiar to the Atomic Bomb.

None.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

Exposed personnel would most likely have suffered from flash burns. Habitability is unimpaired.

(e) Effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

This vessel was outside the effective range of the

explosion in Test A.

V. Preliminary General or Specific Recommendations of Inspection Group.

Inflammable materials should be stowed in sheltered locations or otherwise protected against direct exposure to the radiant heat of the blast.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

Damage to this craft consists of dishing of bulkheads exposed to the blast and moderate fire damage.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Heat scorched paint to a depth of one coat and blistered vertical surfaces facing aft. Lines were scorched.

(b) Fires and explosions.

The wooden mast is almost completely burned off just below the yardarm. A fire on the port quarter burned the contents of some open cans of paint, a wooden plank, and some cable insulation. This fire warped a section of the after bulkhead of the galley and caused severe scorching of paint in the galley.

(c) Shock.

None.

(d) Pressure.

Damage due to blast is confined to the slight dishing of exposed bulkheads and the severe distortion of the angle framing of the flagbag. The critical weight of plating appears to be #10 M.S.

(e) Effects peculiar to the Atomic Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

Exposed personnel would most likely have suffered from flash burns. Habitability is unimparied.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

No comment.

V. Recommendations.

None.

VI. Instructions for Loading the Vessel Specified the Following:

ITEM	LOADING
Diesel oil	Minimum
Ammunition Potable and reserve feed water Salt water ballast.	No special adjustment required.

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

DETAILED DESCRIPTION OF HULL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Hull Damage.

Damage to this vessel consists of the dishing of bulkheads exposed to the blast and moderate fire damage. General views of the craft before and after the test are on pages 40 to 48.

The wooden mast is nearly burned through just below the yardarm. (Photos 2889-6, 7, and 8, pages 46, 45, 44). On the after end of the house top port, a coil of rubber covered electric cable burned. The wheelhouse after bulkhead is slightly dished. The after bulkhead of the starboard deck house is dished slightly. The angle framework of the canvas covered flagbag is severely distorted. The bridge awning is collapsed. Canvas wind screens on the bridge are torn.

E. Weather Deck.

A fire on the port quarter, main deck, burned a bucket of paint, the ends of a plank, and some wood battens. This fire caused slight distortion of the after bulkhead of the galley. The transverse bulwark at the stern is dished forward slightly.

G. Interior Compartments (Above Waterline).

Paint inside the galley is scorched as a result of the fire just outside. There is no other damage.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

The machinery spaces of this vessel was flooded to a depth of about 7 inches. The flooding was from normal seepage through the stern tubes and would not have occured had the crew been aboard.

(b) Structural damage.

No comment.

(c) Other damage.

None, as far as can be determined by visual inspection.

II. Forces evidenced and Effects Noted.

(a) Heat.

No evidence.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

No evidence.

III. Effects of Damage.

(a) Effect on machinery and ship control.

None as far as can be determined by visual inspection. No machinery on this vessel was operated after test "A" because of lack of crews.

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on watertight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

None.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observer's Impressions and Conclusions.

This vessel was outside the effective range of the explosion in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Machinery Damage.

(a) Overall condition.

No damage was evident on visual inspection of the machinery of this vessel. It was not possible to operate and test any machinery because of the lack of a crew.

(b) Areas of major damage.

None.

(c) Primary cause of damage.

None.

(d) Effect of target test on overall operation of the machinery plant.

The operability of the machinery plant was uneffected by the target test as far as could be determined by visual inspection.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Not observed.

(b) Structural damage.

The mast caught fire, burned through about three feet below the yardarm, and fell down alongside the pilot house. The mast-head light cable was parted when the mast fell.

(c) Other damage.

There was no crew aboard and no power available for operating machinery. However, except for two shattered light bulbs and the damage caused by the fire, the electrical equipment suffered no apparent damage.

The exhaust fan in the galley overhead, a blower motor for the galley range and one galley light were inoperable due to damage to their cables from the heat of the fire.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Heat scorched and blistered paint across the stern and along the starboard side. The mast caught fire and burned in two.

(b) Fires and explosions.

The topside fire next to the after bulkhead of the galley occurred when partially filled paint cans ignited. These in turn set fire to a large wooden plank apparently used as a diving board. A heavy coiling of portable cable hanging from a railing above the plank caught fire and its insulation was half burned off.

The heat from the fire caused the complete peeling of paint on the inside of the galley after bulkhead, the thorough blackening of about half of the galley area, and the charring of several cables in the galley.

(c) Shock.

Electrical damage due to shock was confined to the shattering of two light bulbs.

(d) Pressure.

There was no apparent electrical damage due to pressure.

(e) Any effects apparently peculiar to the Atom Bomb.

Except for slight radioactivity, there were no effects on electrical equipment apparently peculiar to the Atom Bomb.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

Not observed.

(d) Effect on personnel and habitability.

The effects on personnel and habitability due to failure of electrical equipment were minor effects on comfort due to loss of some lighting, a galley ventilation fan and a range blower.

(e) Total effect on fighting efficiency.

Negligible.

IV. General Summary of Observers' Impressions and Conclusions.

With proper stowage of inflammable material it is believed that this ship, at the position it occupied in this test, would have survived the blast with nothing more serious to electrical equipment than the parting of the masthead light cable and the shattering of two light bulbs.

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

Inflammable materials should be stowed in sheltered locations or otherwise protected against direct exposure to the radiant heat of the blast.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Electrical Damage.

(a) Overall condition.

The electrical equipment survived with minor damage due to fire.

(b) Areas of major damage.

Practically all electrical damage was confined to the after third of the galley.

(c) Primary causes of damage in each area of major damage.

The primary cause of damage in the galley was heat conducted from a fire outside the after bulkhead.

(d) Effect of target test on overall operation of electric plant.

The ship was not inhabited and the following remarks as to operability are based on a comparison by visual inspection between conditions before the test and those after the test.

1. Ship's service generator plant - operable.

2. Engine and boiler auxiliaries - engine auxiliaries operable.

3. Electrical propulsion - not applicable.

4. Communications - operable.

5. Fire control circuits - not applicable.

6. Ventilation - the exhaust ventilation blower in the overhead of the galley was inoperable due to damage to its cable from heat.

7. Lighting - the after overhead light in the galley would not operate due to its cable from heat. The masthead light was inoperable.

(e) Types of equipment most affected.

1. Switchboards and switchgear - unaffected.

2. Rotating machinery - unaffected.

3. Motor controllers - unaffected.

4. Cables and supports - cables in galley suffered heat damage. The masthead light cable parted.

G. Wiring, Wiring Equipment, and wireways.

(a) Cable.

A three-foot length of navy standard HFA cable to the overhead exhaust blower motor in the galley, where clipped with standard clips to the after bulkhead of the galley, was damaged by heat conducted through the bulkhead from a fire which occurred against the bulkhead on the outside. The insulation melted out through the woven cable armor. For at least a two-foot section, the diameter of the cable was noticeably reduced and the molten insulation stood out in large charred globules. This damage is not considered unusual but rather that which is to be expected of cable subjected to excessive heat.

Navy standard HFA cable to the galley range blower motor suffered the same damage described above.

Navy standard HFA cable to the after galley lighting fixture suffered the same damage described above.

The masthead light cable parted when the top of the mast burned through and was dislodged.

A heavy coiling of portable cable, probably DCP-14, about forty feet in length and located topside on a railing, caught on fire when adjacent wood and paint was set on fire by the blast. The cable insulation was about half consumed, exposing the bare wire.

L. Lighting Equipment.

(a) Lamps.

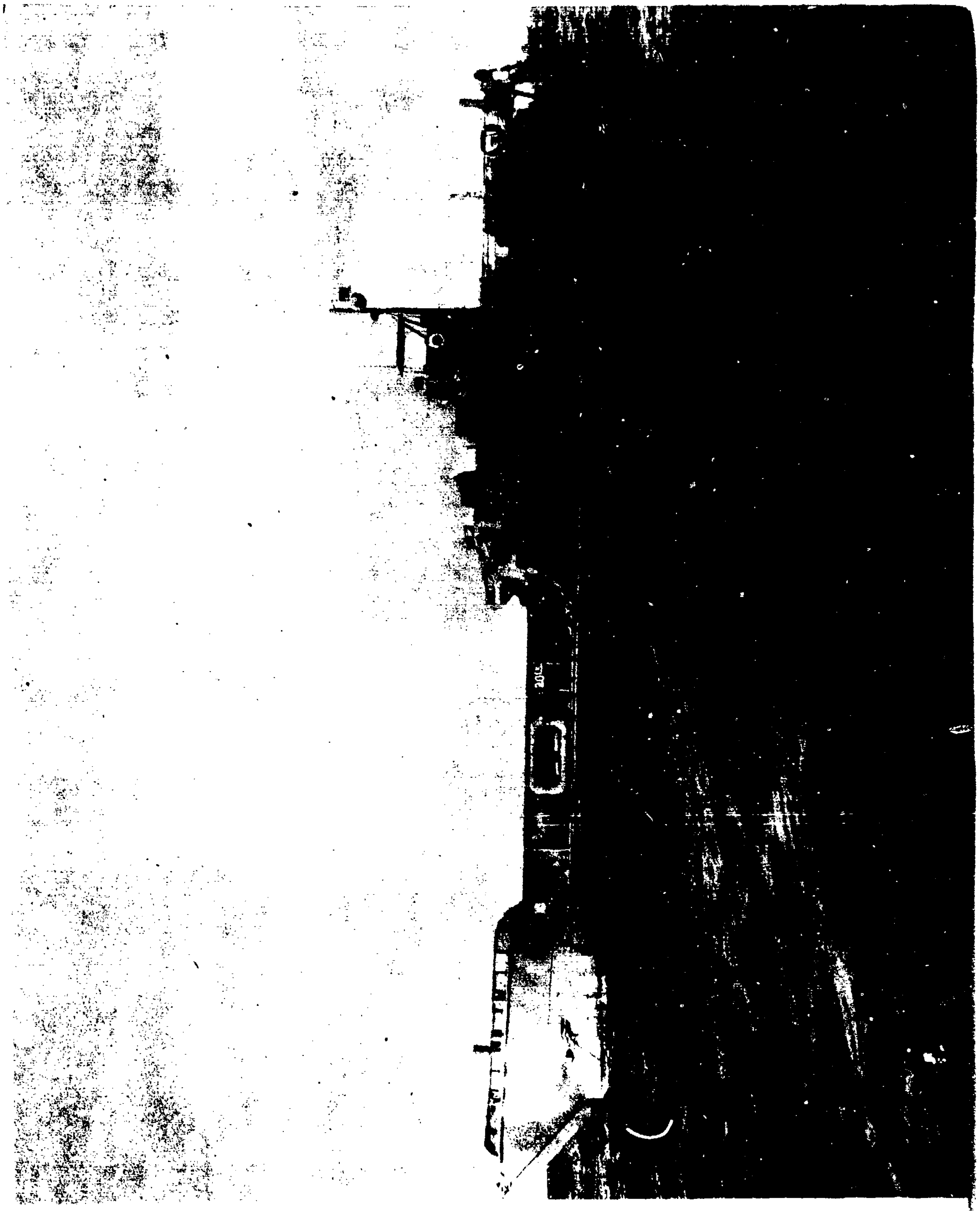
There were two shattered lamps in the ship. One was a 100-watt blue-colored lamp in the fixture on the after bulkhead of the crew's washroom. The fixture was not shock mounted but bolted directly to the bulkhead. The other shattered lamp was a 50-watt lamp in a non-shock mounted overhead fixture in the forward part of the galley.

The mast had caught fire and burned through about three feet below the yardarm, dislodging the top part of the mast and the masthead light. The masthead light cable parted when the top of the mast fell.

APPENDIX

PHOTOGRAPHS

TEST ABLE



BA-CR-196-165-1. View from off port beam before Test A.

BA-CR-196-165-5. View from off starboard beam before Test A.

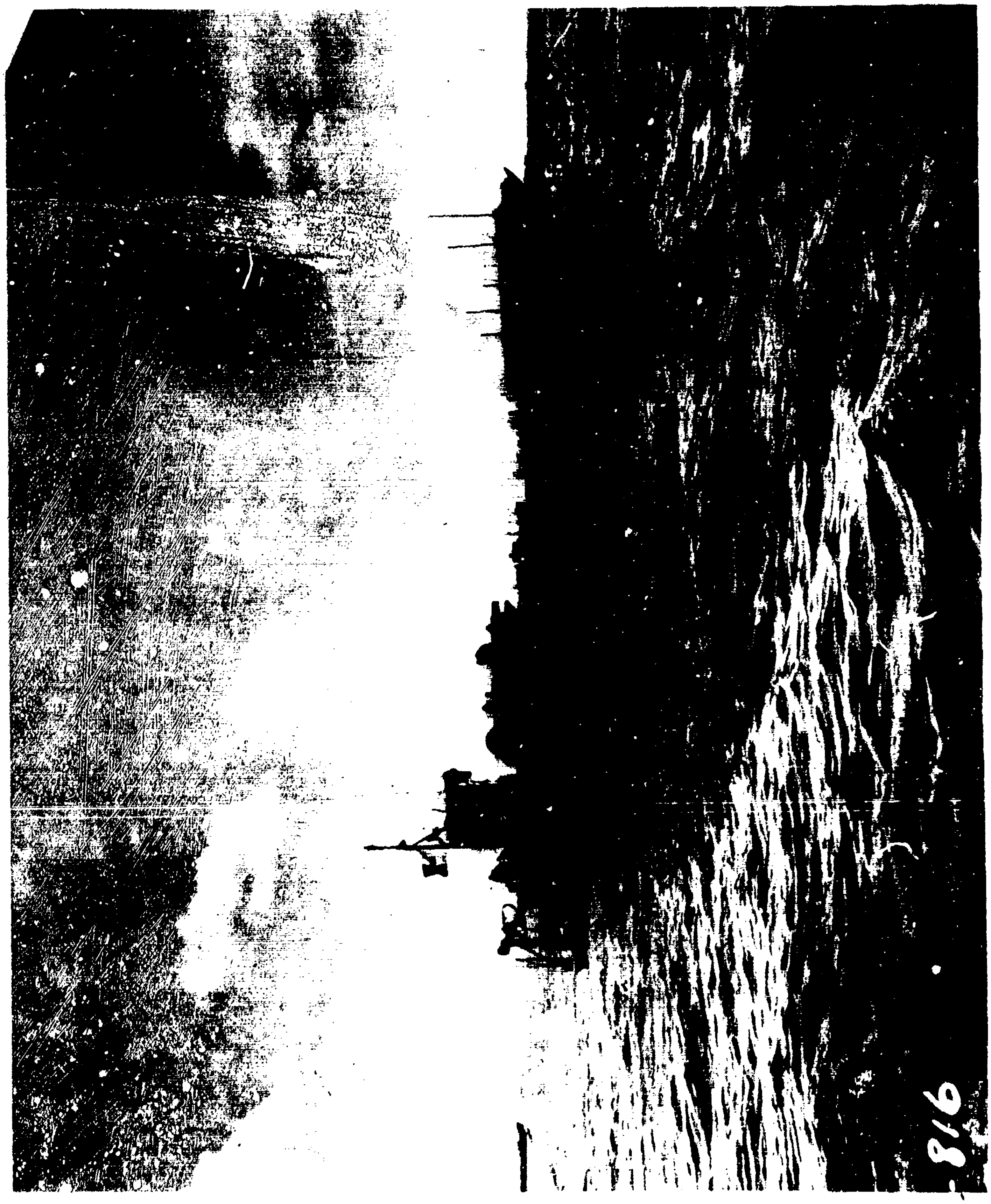
AA-CR-218-2889-10. View from off port bow after Test A.

AA-CR-218-2889-9. View from off port beam after Test A.

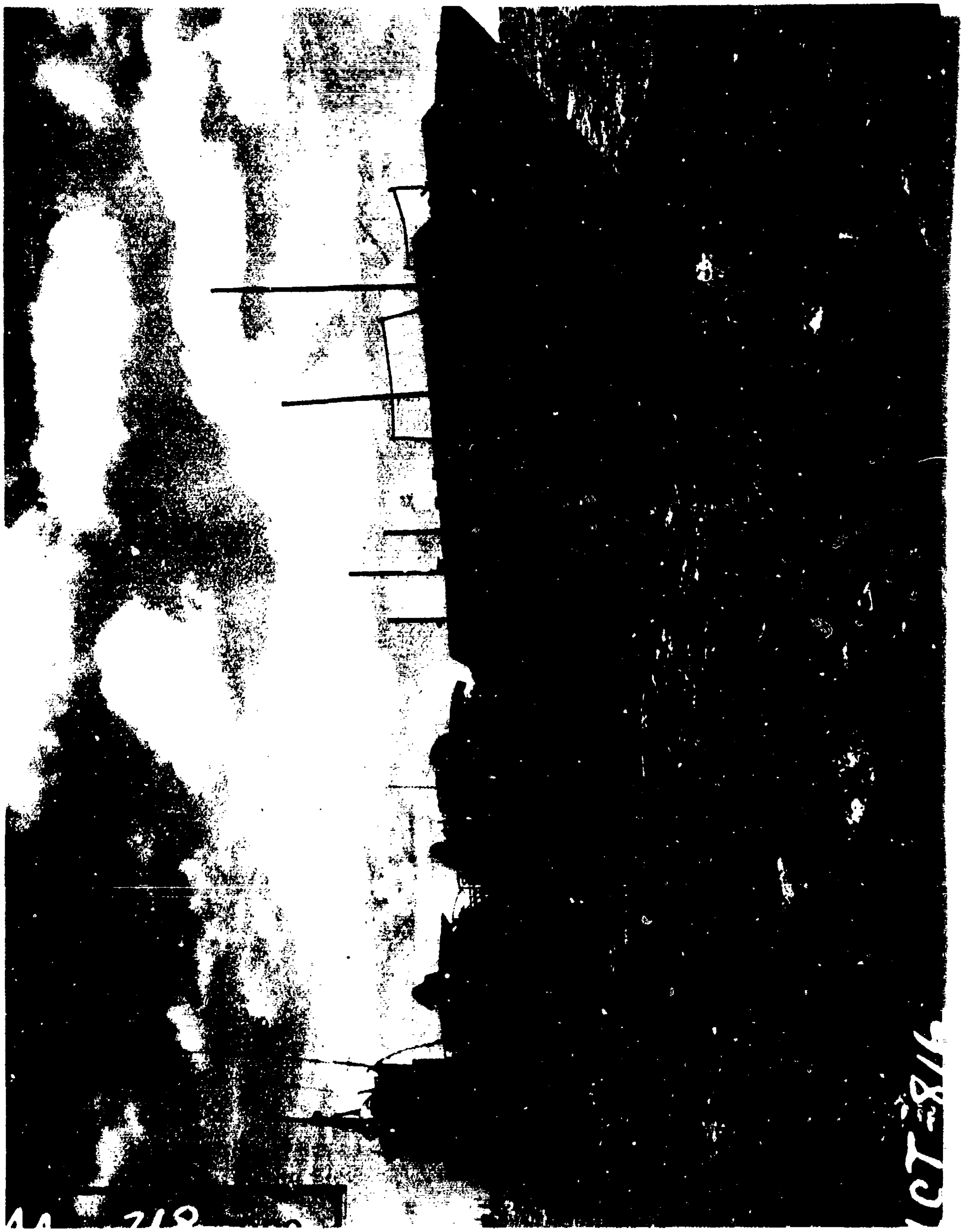
AA-CR-218-2889-8. View from off port quarter after Test A.

AA-CR-218-2889-7. View from astern after Test A.

AA-CR-218-2889-6. View from off starboard quarter after Test A.



AA-CR-218-2889-5. View from off starboard beam after Test A.



AA-CR-218-2889-4. View from off starboard bow after Test A.

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test, general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

Structural damage is negligible. The flag bag is dished. Screens in a few ventilation system are torn loose.

(c) Other damage.

None.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Normal to the blast, some paint is slightly scorched. Some lines are slightly scorched.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

Pressures of low intensity are indicated by dishing of the flag bag and screens in the ventilation system.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

No apparent effect.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

This vessel was outside the effective range of the explosion in Test A.

V. Preliminary Recommendations.

None.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

Structural damage is negligible. The flagbag is dished. Screens in a few ventilation systems are torn loose.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Normal to the blast, some paint is slightly scorched. Some lines are slightly scorched.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

Pressures of low intensity are indicated by dishing of the flagbag and screens in the ventilation system.

(e) Effects peculiar to the Atomic Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

No comment.

V. Recommendations.

None.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

Structural damage is negligible. The flagbag is dished. Screens in a few ventilation systems are torn loose.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Normal to the blast, some paint is slightly scorched. Some lines are slightly scorched.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

Pressures of low intensity are indicated by dishing of the flagbag and screens in the ventilation system.

(e) Effects peculiar to the Atomic Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

No comment.

V. Recommendations.

None.

VI. Instructions for Loading the Vessel Specified the Following:

ITEM	LOADING
Diesel oil	Minimum
Ammunition	No special ad-
Potable and reserve feed water	justment re-
Salt water ballast	quired.

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

DETAILED DESCRIPTION OF HULL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Hull damage.

Damage is negligible, entirely confined to the topside, and was caused by blast. Some lines are scorched. Normal to the blast, some paint is slightly scorched. There were no fires.

B. Superstructure.

The flagbag is dished from blast. Screens in a few ventilation systems are torn loose. Some lines are slightly scorched. Paint on exposed surfaces was somewhat scorched.

T. Coverings.

Normal to the blast, some paint is slightly scorched.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

No comment.

(b) Structural damage.

No comment.

(c) Other damage.

None, as far as can be determined by visual inspection.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence on machinery of this vessel.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

No evidence.

III. Effects of Damage.

(a) Effects on machinery and ship control.

None, as far as can be determined by visual inspection. No machinery was operated or tested after Test "A".

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on water tight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

None.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

The ship sustained no damage whatsoever. It was outside the effective range of the explosion in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Machinery Damage.

(a) Overall condition.

Test "A" had no effect on the machinery of this vessel. As far as could be determined by visual inspection, there was no damage.

(b) Areas of major damage.

None.

(c) Primary cause of damage.

None.

(d) Effect of target test on overall operation of the machinery plant.

The operability of the machinery plant was not effected by the target test as far as could be determined by visual inspection.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Not observed.

(b) Structural damage.

Not observed.

(c) Other damage.

The electrical equipment suffered no apparent damage or loss of operability, either directly or indirectly due to the Atom Bomb. None of the electrical equipment had been operated at the time of inspection as the ship's crew had not returned.

II. Forces Evidenced and Effects Noted.

(a) Heat.

There was no evidence of heat effects on electrical equipment, although exposed paint and lines were scorched.

(b) Fires and explosions.

None.

(c) Shock.

There was no apparent shock damage to electrical equipment.

(d) Pressure.

There was no evidence of pressure damage to elecyrical equipment.

(e) Any effects apparently peculiar to the Atom Bomb.

Other than radioactivity, there were no effects apparently peculiar to the Atom Bomb ascertainable from the condition of electrical equipment.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

No apparent effect.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

This ship was located at too great a distance from the bomb blast to suffer any damage to electrical equipment, either directly or indirectly attributable to the blast.

V. **Any Preliminary General or Specific Recommendations of the Inspecting Group.**

None.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

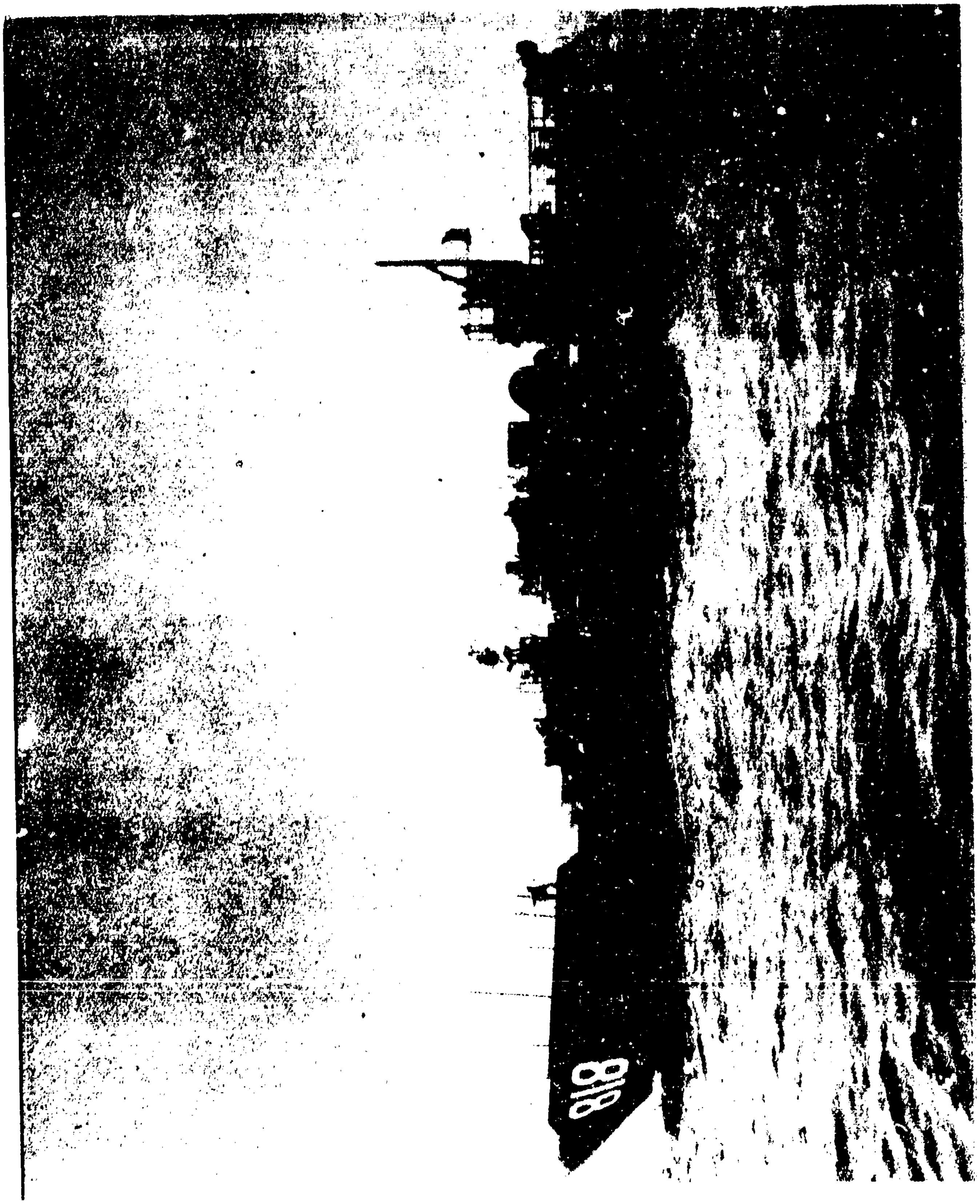
There was no damage.

APPENDIX

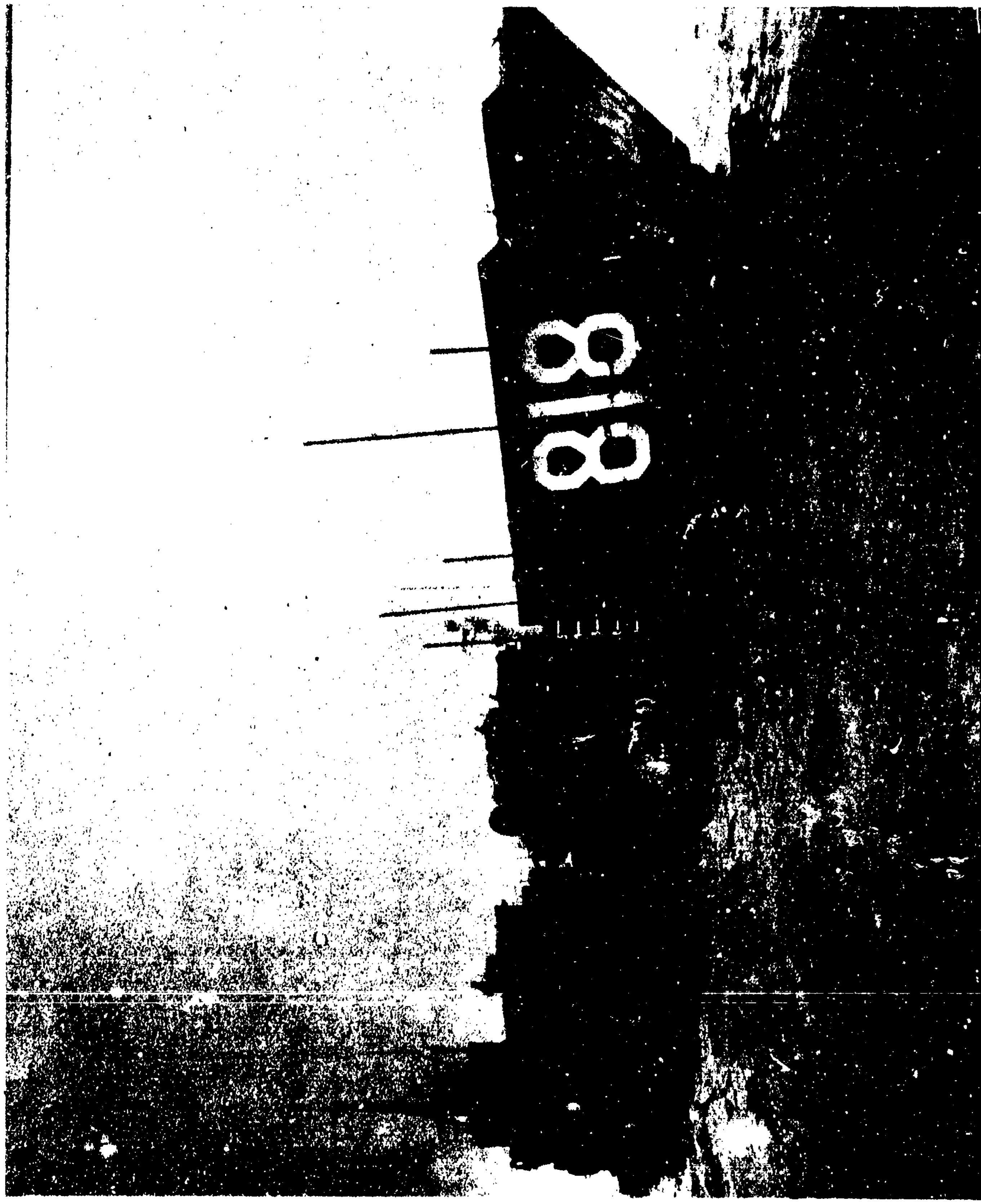
PHOTOGRAPHS

TEST ABLE

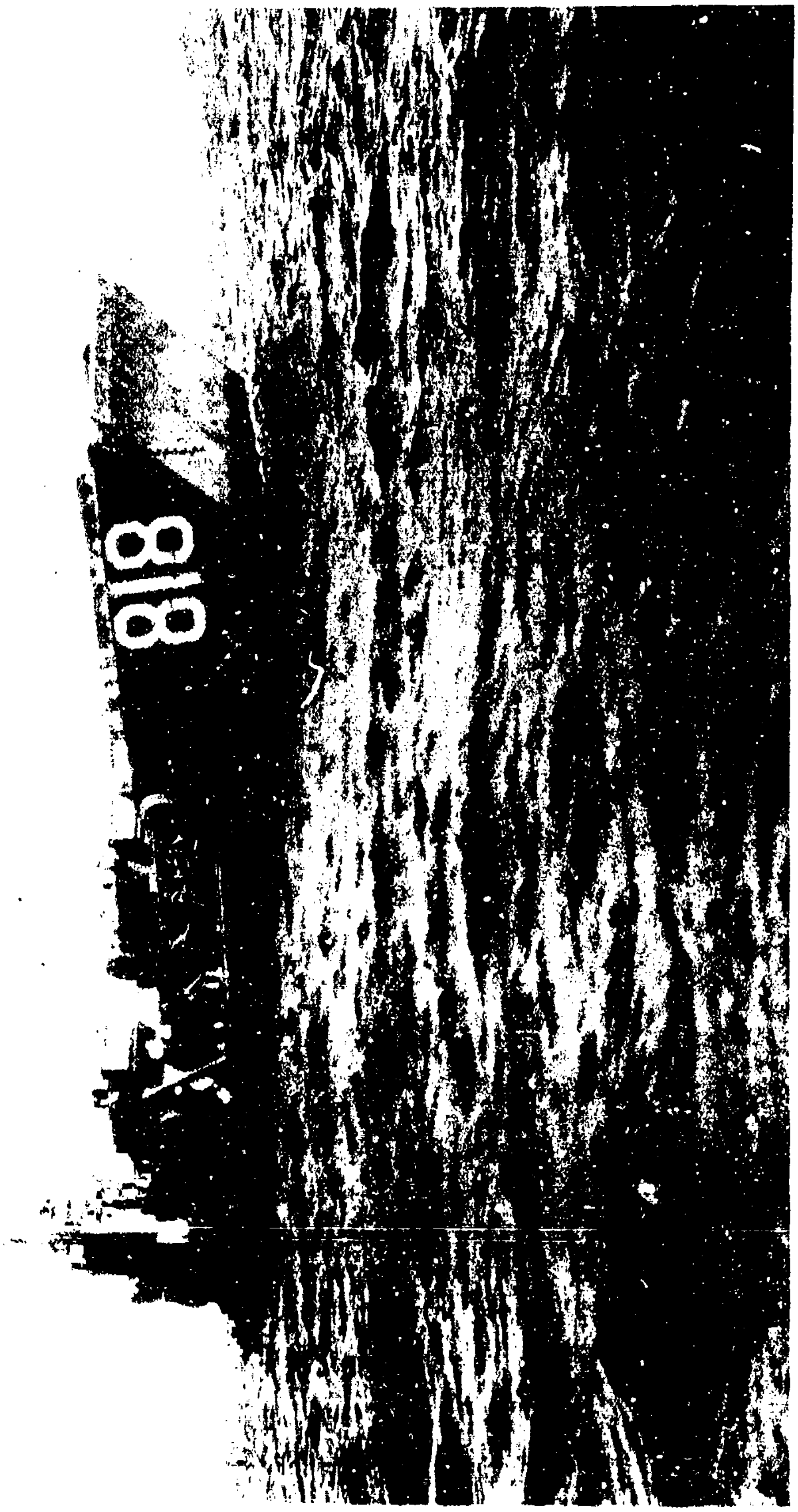
BA-CR-196-165-10. View from port beam before Test A.



AA-CR-227-92-27. View from port beam after Test A.



AA-CR-227-92-22. View from starboard bow after Test A.



BA-CR-196-165-13. View from starboard bow before Test A.

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; general areas of flooding.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

No damage.

(c) Other damage.

None.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

This vessel was outside the effective range of the explosion in Test A.

V. Preliminary Recommendations.

None.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

No damage.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

No comment.

V. Recommendations.

None.

VI. Instructions for Loading the Vessel Specified the Following:

ITEM	LOADING
Diesel oil	Minimum.

ITEM	LOADING
Ammunition Potable and reserve feed water Salt water ballast.	No special adjustment required.

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

DETAILED DESCRIPTION OF HULL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Hull Damage.

Damage is negligible. Blast pressure caused upward bending of the ends of sun shields on ready service lockers and the bending of a sheet metal running light guard.

B. Superstructure.

Blast pressure caused upward bending of the ends of sun shields on ready service lockers and bending of a sheet metal running light guard.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

No comment.

(b) Structural damage.

No comment.

(c) Other damage.

None, as far as can be determined by visual inspection.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence on machinery of this vessel.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

No evidence.

III. Effects of Damage.

(a) Effects on machinery and ship control.

None, as far as can be determined by visual inspection. No machinery was operated or tested after Test "A".

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on water-tight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

None.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

The ship sustained no damage whatsoever. It was outside the effective range of the explosion in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Machinery Damage.

(a) Overall condition.

Test "A" had no effect on the machinery of this vessel. As far as could be determined by visual inspection, there was no damage.

(b) Areas of major damage.

None.

(c) Primary cause of damage.

None.

(d) Effect of target test on overall operation of the machinery plant.

The operability of the machinery plant was not effected by the target test as far as could be determined by visual inspection.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Conditio. After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Not observed.

(b) Structural damage.

Not observed.

(c) Other damage.

The electrical equipment suffered no apparent damage or loss of operability, either directly or indirectly due to the atom bomb. None of the electrical equipment had been operated at the time of inspection as the ship's crew had not returned.

II. Forces Evidenced and Effects Noted.

(a) Heat.

There was no evidence of heat effects on electrical equipment.

(b) Fires and explosions.

None.

(c) Shock.

There was no evidence of shock damage.

(d) Pressure.

There was no evidence of pressure damage.

(e) Any effects apparently peculiar to the Atom Bomb.

None.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

Not observed.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

From an electrical standpoint this ship was beyond the range of damage.

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

There was no damage.

APPENDIX

PHOTOGRAPHS

TEST ABLE

AA-CR-227-92-18. View from port beam after Test A.

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; general areas of flooding, sources.

The engine room spaces flooded to a depth of 6 inches through the stern tubes which were leaking before the test. There is no appreciable change in draft, list or trim.

(b) Structural damage.

No damage.

(c) Other damage.

None.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

This vessel was outside the effective range of the explosion in Test A.

V. Preliminary Recommendations.

None.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

The engine room spaces flooded to a depth of 6 inches through the stern tubes which were leaking before the test. There is no appreciable change in draft, list or trim.

(b) Structural damage.

No damage.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

No comment.

V. Recommendations.

No comment.

VI. Instructions for Loading the Vessel Specified the Following:

ITEM	LOADING
Diesel oil	Minimum

ITEM	LOADING
Ammunition Potable and reserve feed water Salt water ballast	No special ad- justment re- quired.

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships Crossorads Files.

DETAILED DESCRIPTION OF HULL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

L. Flooding.

There is 6 inches of water in the engine room compartments. This water entered through the packing glands around the propeller shafts which were leaking before the test.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

The machinery spaces of this vessel was flooded to a depth of about 7 inches. The flooding was from normal seepage through the stern tubes and would not have occured had the crew been aboard.

(b) Structural damage.

No comment.

(c) Other damage.

None, as far as can be determined by visual inspection.

II. Forces evidenced and Effects Noted.

(a) Heat.

No evidence.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

No evidence.

III. Effects of Damage.

(a) Effect on machinery and ship control.

None as far as can be determined by visual inspection. No machinery on this vessel was operated after test "A" because of lack of crews.

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on watertight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

None.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observer's Impressions and Conclusions.

This vessel was outside the effective range of the explosion in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Machinery Damage.

(a) Overall condition.

No damage was evident on visual inspection of the machinery of this vessel. It was not possible to operate and test any machinery because of the lack of a crew.

(b) Areas of major damage.

None.

(c) Primary cause of damage.

None.

(d) Effect of target test on overall operation of the machinery plant.

The operability of the machinery plant was uneffected by the target test as far as could be determined by visual inspection.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Drafts and list were not observed. There was no flooding.

(b) Structural damage.

None.

(c) Other damage.

This vessel received no electrical damage as a result of test "A".

II. Forces Evidence and Effects Noted.

(a) Heat.

There was no evidence of heat.

(b) Fires and explosions.

There was no evidence of fires or explosions.

(c) Shock.

There was no evidence of shock.

(d) Pressure.

There was no evidence of pressure.

(e) Any effects apparently peculiar to the Atom Bomb.

There was no effects noted that are considered peculiar to the Atomic Bomb other than radioactivity.

III. Effects of Damage.

(a) Effect on electric plant and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

The only effects on personnel and habitability would have been due to radioactivity. The extent of such effects is unknown.

(e) Total effect on fighting efficiency.

The only effect on the vessel's fighting efficiency would have been from possible personnel casualties as a result of radioactivity. From a material stanpoint there was no effect on the vessels fighting efficiency.

IV. General Summary of Observer's Impressions and Conclusions.

It is considered that this vessel was too far from the center of the blast to suffer damage as a result of this test.

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

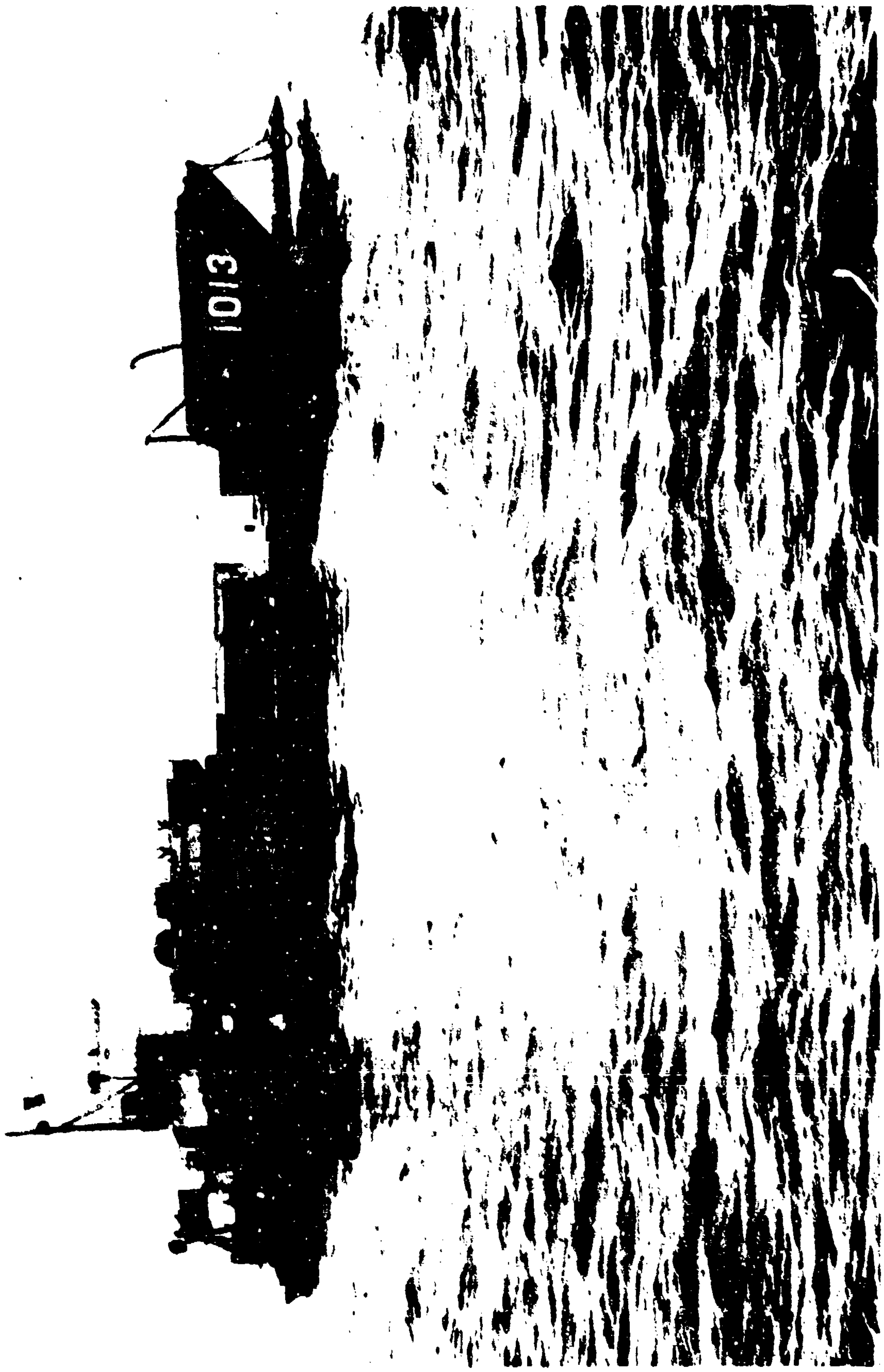
NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

There was no damage.

APPENDIX

PHOTOGRAPHS

TEST ABLE



AA-CR-227-87-49. View from starboard beam after Test A.

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test, general areas of flooding.

There was no flooding, hence no change in draft or list.

(b) Structural damage.

The mast is broken just above the diagonal braces and the starboard yardarm is broken off.

(c) Other damage.

None.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

Blast pressure caused displacement of the flag bag and was probably responsible for the mast and yardarm damage. Soot was blown from ducts into the galley and nearby living spaces.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

This vessel was outside the effective range of the explosion in Test A.

V. Preliminary Recommendations.

None.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in draft or list.

(b) Structural damage.

The mast is broken just above the diagonal braces and the starboard yardarm is broken off.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions

None.

(c) Shock.

None.

(d) Pressure.

Blast pressure caused displacement of the flagbag and was probably responsible for the mast and yardarm damage. Soot was blown from ducts into the galley and nearby living spaces.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personne and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

No comments.

V. Recommendations.

None.

VI. Instructions for Loading the Vessel Specified the Following:

ITEM	LOADING
Diesel oil	Minimum
Ammunition	No special adjustment required.
Potable and reserve feed water	
Salt water ballast	

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

DETAILED DESCRIPTION OF HULL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Hull Damage.

The mast which is broken above the diagonal braces and the starboard yardarm is broken off. The flag bag is slightly displaced. There is no other damage.

B. Superstructure.

The mast, a square hollow wood structure, is broken just above the diagonal braces and is bent slightly aft. It is reported that the mast was broken before the test. Photographs indicate that the mast leaned much more after the test than before. The signal yardarm on the starboard side is broken off. The flagbag is slightly displaced.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

No comment.

(b) Structural damage.

No comment.

(c) Other damage.

None, as far as can be determined by visual inspection.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence on machinery of this vessel.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

No evidence.

III. Effects of Damage.

(a) Effects on machinery and ship control.

None, as far as can be determined by visual inspection. No machinery was operated or tested after Test "A".

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on water-tight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

None.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

The ship sustained no damage whatsoever. It was outside the effective range of the explosion in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Machinery Damage.

(a) Overall condition.

Test "A" had no effect on the machinery of this vessel. As far as could be determined by visual inspection, there was no damage.

(b) Areas of major damage.

None.

(c) Primary cause of damage.

None.

(d) Effect of target test on overall operation of the machinery plant.

The operability of the machinery plant was not effected by the target test as far as could be determined by visual inspection.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Not observed.

(b) Structural damage.

Not observed.

(c) Other damage.

The electrical equipment suffered no apparent damage or loss of operability, either directly or indirectly due to the Atom Bomb. None of the electrical equipment had been operated at the time of inspection as the ship's crew had not returned. Some minor items of electrical equipment apparer'ly were cannabalized after Test "A".

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence.

(b) Fires and explosions.

None.

(c) Shock.

There was one shattered light bulb in a ceiling fixture and one displaced starting solenoid for a propulsion engine in the star-

board engine space. However, it is believed that this was due to cannabalizing after Test "A" rather than to shock. There was no other electrical damage attributable to shock.

(d) Pressure.

There was no evidence of pressure damage.

(e) Any effects apparently peculiar to the Atom Bomb.

None.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

Not observed.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

This ship was beyond the range of damage to its electrical equipment in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

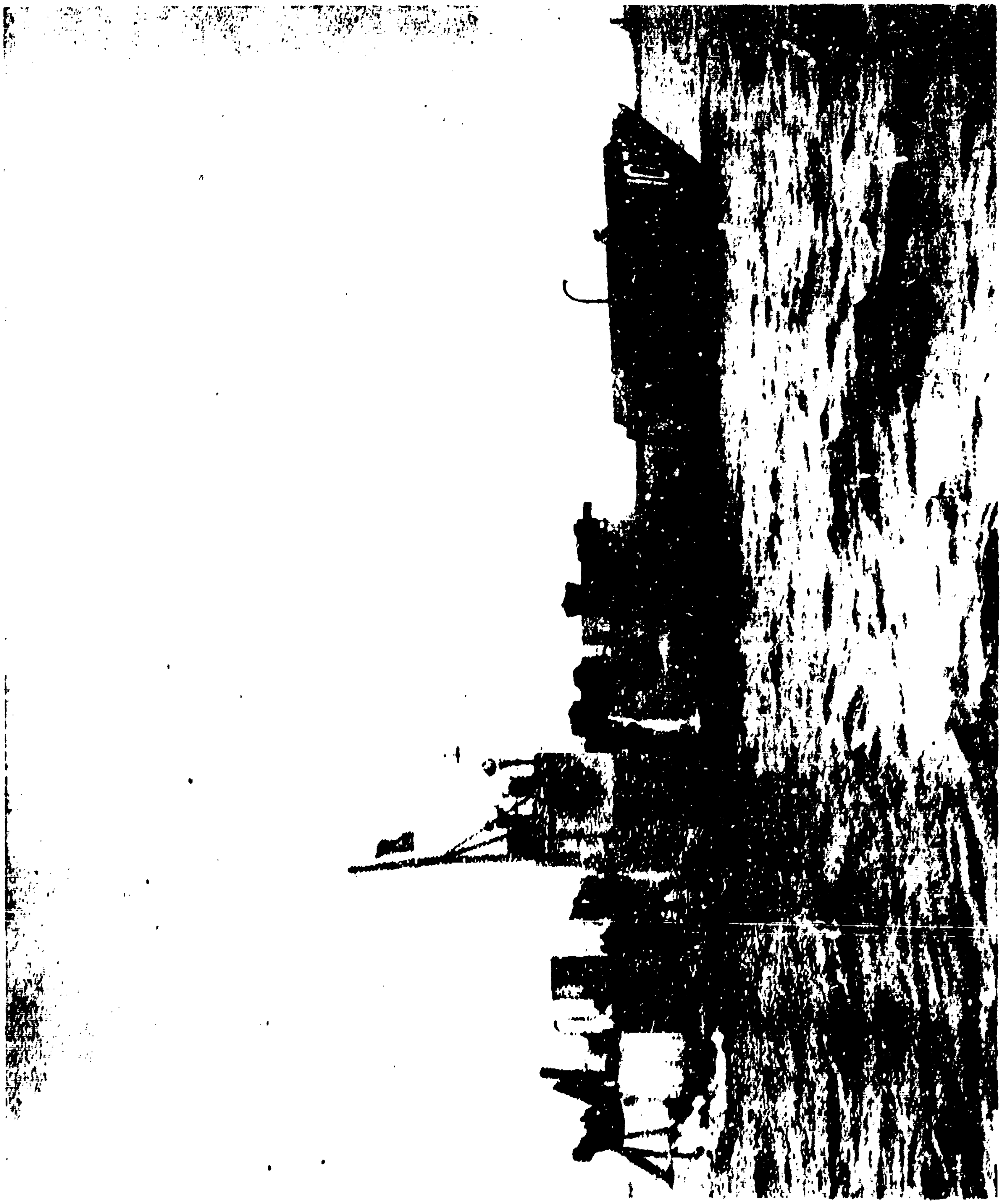
There was no damage.

APPENDIX

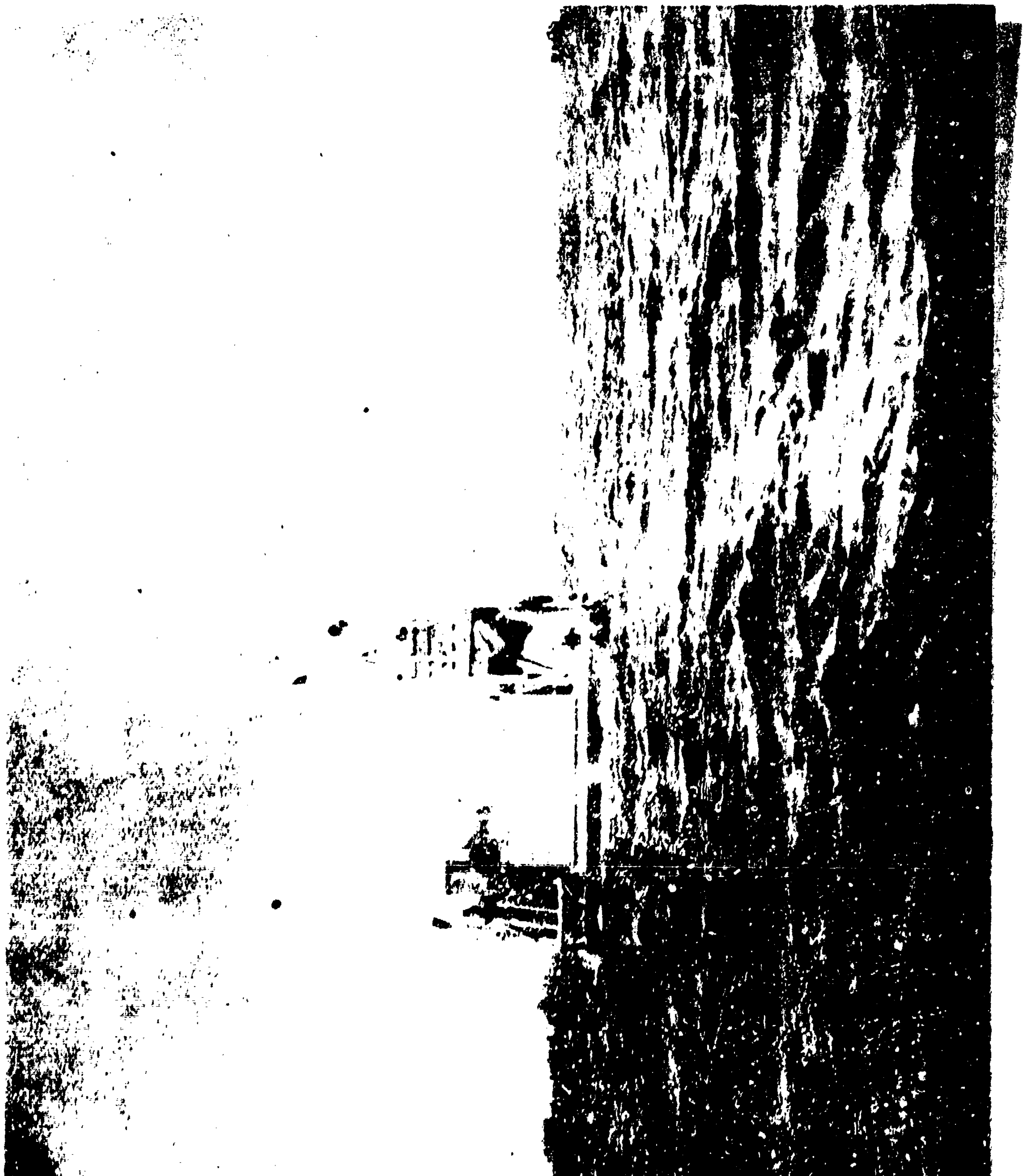
PHOTOGRAPHS

TEST ABLE

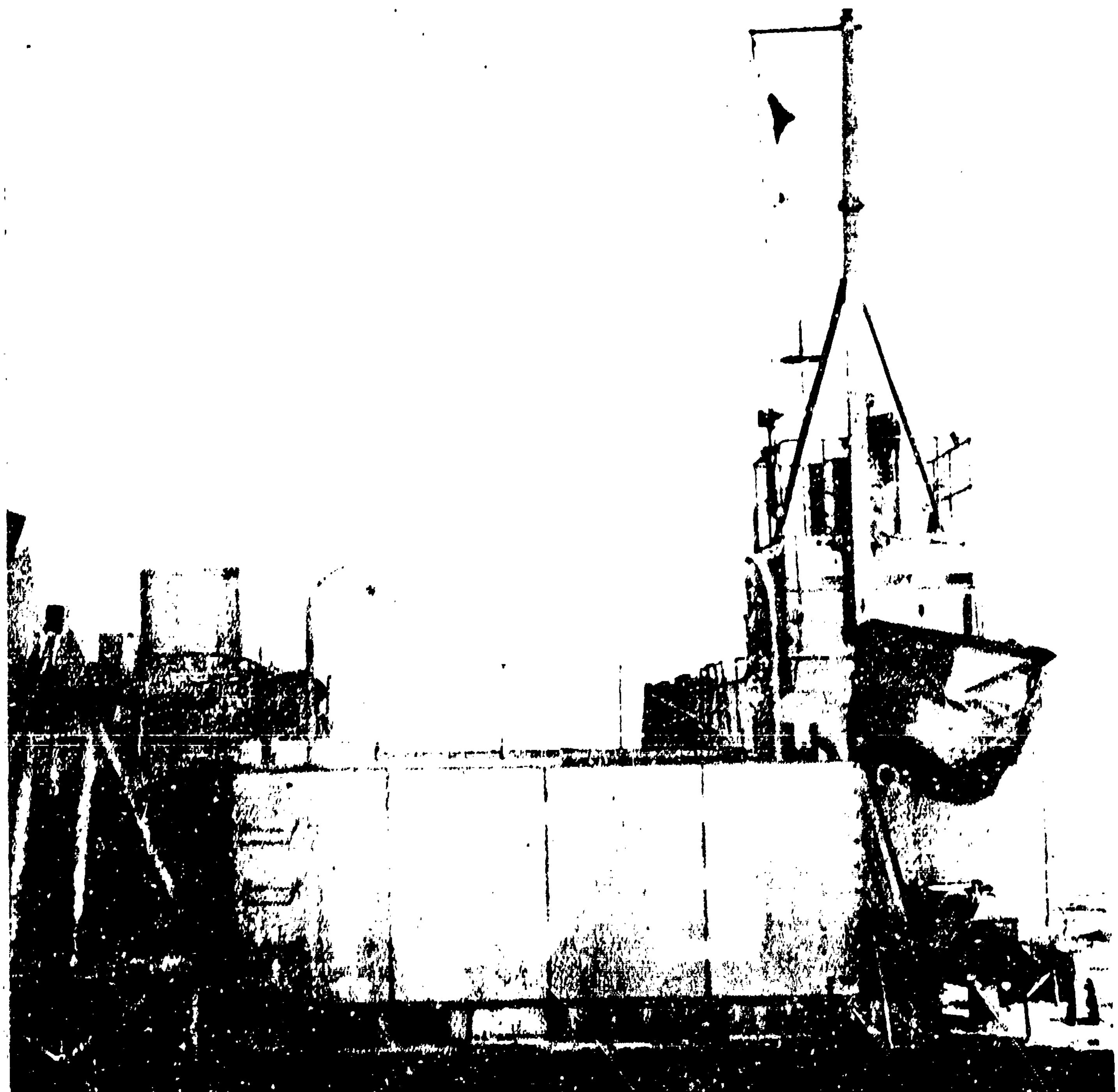
BA-CR-196-166-3. View from starboard quarter before Test A.



AA-CR-227-92-10. View from starboard quarter after Test A.



BA-CR-196-166-4. View from stern before Test B.



AA-CR-227-92-4. View from stern after Test B.

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test, general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

No damage.

(c) Other damage.

None.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

This vessel was outside the effective range of the explosion in Test A.

V. Preliminary Recommendations.

None.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

No damage.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atomic Bomb.

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

No comments.

V. Recommendations.

None.

VI. Instructions for Loading the Vessel Specified the Following:

ITEM	LOADING
Diesel oil	Minimum

ITEM	LOADING
Ammunition Potable and reserve feed water Salt water ballast	No special adjustment required.

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

DETAILED DESCRIPTION OF HULL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

There was no damage.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Tartet Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

No comment.

(b) Structural damage.

No comment.

(c) Other damage.

None, as far as can be determined by visual inspection.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence on machinery of this vessel.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

No evidence.

III. Effects of Damage.

(a) Effects on machinery and ship control.

None, as far as can be determined by visual inspection. No machinery was operated or tested after Test "A".

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on water-tight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

None.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

The ship sustained no damage whatsoever. It was outside the effective range of the explosion in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Machinery Damage.

(a) Overall condition.

Test "A" had no effect on the machinery of this vessel. As far as could be determined by visual inspection, there was no damage.

(b) Areas of major damage.

None.

(c) Primary cause of damage.

None.

(d) Effect of target test on overall operation of the machinery plant.

The operability of the machinery plant was not effected by the target test as far as could be determined by visual inspection.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Not observed.

(b) Structural damage.

Not observed.

(c) Other damage.

The electrical equipment suffered no apparent damage or loss of operability, either directly or indirectly due to the Atom Bomb. None of the electrical equipment had been operated at the time of inspection as the crew had not returned.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence.

(b) Fires and explosions.

None.

(c) Shock.

There was no evidence of shock damage.

(d) Pressure.

There was no evidence of pressure damage.

(e) Any effects apparently peculiar to the Atom Bomb.

None other than radioactivity.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

Not observed.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

This ship was beyond the range of damage to its electrical equipment in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

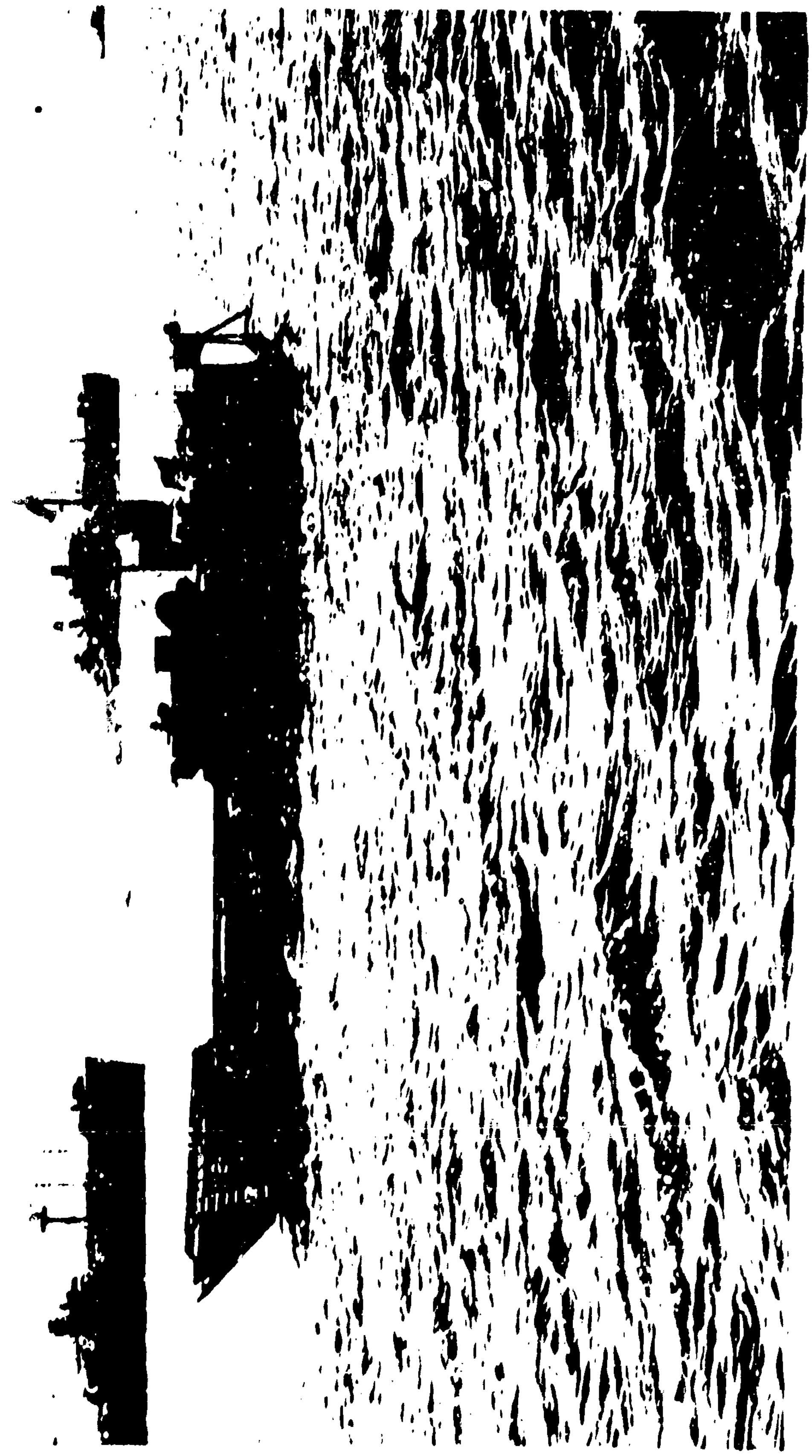
NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

There was no damage.

APPENDIX

PHOTOGRAPHS

TEST ABLE



AA-CR-227-87-104. View from port beam after Test A.

BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test, general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

No damage.

(c) Other damage.

None.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atom Bomb.

None.

III. Results of Test on Target.

(a) Effects on machinery, electrical, and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary.

This vessel was outside the effective range of the explosion in Test A.

V. Preliminary Recommendations.

None.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

No damage.

(c) Other damage.

Not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None.

(b) Fires and explosions.

None.

(c) Shock.

None.

(d) Pressure.

None.

(e) Effects peculiar to the Atomic Bomb.

None.

III. Results of Test on Target.

(a) Effects on machinery, electrical, and ship control.

Not observed.

(b) Effect on gunnery and fire control.

Not observed.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None.

IV. General Summary

No comment.

V. Recommendation.

None.

VI. Instructions for Loading the Vessel Specified the Following:

ITEM	LOADING
Diesel oil	Minimum

ITEM	LOADING
Ammunition Potable and reserve feed water Salt water ballast	No special adjustment required.

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Materail. This report is available for inspection in the Bureau of Ships Crossroads Files.

DETAILED DESCRIPTION OF HULL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

There was no damage.

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

No comment.

(b) Structural damage.

No comment.

(c) Other damage.

None, as far as can be determined by visual inspection.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence on machinery of this vessel.

(b) Fires and explosions.

No evidence.

(c) Shock.

No evidence.

(d) Pressure.

No evidence.

III. Effects of Damage.

(a) Effects on machinery and ship control.

None, as far as can be determined by visual inspection. No machinery was operated or tested after Test "A".

(b) Effect on gunnery and fire control.

No comment.

(c) Effect on water-tight integrity and stability.

No comment.

(d) Effect on personnel and habitability.

None.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

The ship sustained no damage whatsoever. It was outside the effective range of the explosion in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

NCTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Machinery Damage.

(a) Overall condition.

Test "A" had no effect on the machinery of this vessel. As far as could be determined by visual inspection, there was no damage.

(b) Areas of major damage.

None.

(c) Primary cause of damage.

None.

(d) Effect of target test on overall operation of the machinery plant.

The operability of the machinery plant was not effected by the target test as far as could be determined by visual inspection.

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Not observed.

(b) Structural damage.

Not observed.

(c) Other damage.

The electrical equipment suffered no apparent damage or loss of operability, either directly or indirectly due to the Atom Bomb. None of the electrical equipment had been operated at the time of inspection as the ship's crew had not returned. The leakage of water, apparently through the stern tubes, had caused some water to accumulate in the machinery spaces. Some electrical equipment in the machinery spaces may therefore be inoperable due to moisture grounds.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence.

(b) Fires and explosions.

None.

(c) Shock.

There was no evidence of shock damage.

(d) Pressure.

There was no evidence of pressure damage.

(e) Any effects apparently peculiar to the Atom Bomb.

None other than radioactivity.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

None other than due to possible moisture grounds.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

Not observed.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

None other than due to possible moisture grounds.

IV. General Summary of Observers' Impressions and Conclusions.

This ship was beyond the range of damage to its electrical equipment in Test "A".

V. Any Preliminary General or Specific Recommendations of the Inspecting Group.

None.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

NOTE: The only items discussed below are those where damage occurred. All items omitted either received no damage or are not applicable.

A. General Description of Electrical Damage.

(a) Overall condition.

No visible damage to electrical equipment other than that possibly due to the presence of salt water in the machinery spaces.

(b) Areas of major damage.

None.

(c) Primary causes of damage in each area of major damage.

None.

(d) Effect of target test on overall operation of electric plant.

The operability of the electric plant apparently was not impaired by any direct or indirect effects of the Atom Bomb. None of the electrical equipment was operated, however, as the ship's crew had not returned. The leakage of water, apparently through the stern tubes, had caused some water to accumulate in the machinery spaces. Some electrical equipment in the machinery spaces may therefore be inoperable due to moisture grounds.

(e) Types of equipment most affected.

None.

APPENDIX

PHOTOGRAPHS

TEST ABLE

AA-CR-227-87-107. View from starboard beam after 1

(14) XRD-200

CONFIDENTIAL

(10) Irwin Vigness,

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(6) OPERATION CROSSROADS

Report of

BUREAU OF SHIPS INSTRUMENTATION GROUP,

SECTION IX.

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~~Director~~
~~Defense Atomic Support Agency~~
~~Washington, D. C. 20301~~

(8)

DISPLACEMENTS OF SHOCK MOUNTED EQUIPMENT (U),

(11) 1947,

(12) 94p.

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Report On

DISPLACEMENTS OF SHOCK MOUNTED EQUIPMENT

This report was prepared by Dr. IRWIN VIGNESS of the Naval Research Laboratory. The work was carried out under his direction, assisted by Mr. J. P. WALSH and Lieutenant PERRY EGBERT, USNR, also of the Naval Research Laboratory.

TABLE OF CONTENTS

MAXIMUM RELATIVE DISPLACEMENTS OF SHOCK MOUNTED APPARATUS WITH RESPECT TO THEIR SUPPORTS

("X" Gage Measurements)

INTRODUCTION

Objectives

1. A considerable amount of Navy gear mounted aboard ship is held in position by flexible supports. These equipments have several modes of vibrations whose frequencies are easily determinable. The maximum displacements of these equipments with respect to their supports are of interest from the viewpoint of the suitability of the mounts in protecting the equipments from damage and also from the viewpoint of determining the relative intensities of shock at different locations on a ship. The lower modes of vibrations of the mounted equipments are generally in the range between 4 and 20 cps. As the response (the "response" of a point on an equipment is considered to be the maximum displacement of that point with respect to its supports) of an equipment is dependent on the type of mounting and the position of measurement it is practical only to compare responses of similar equipment at given locations on the equipments, although sufficient data are included so that a more extensive analysis is possible.

2. The principal objectives to be gained from measurements of maximum displacements of shock mounted equipments with respect to their supports are therefore:

A. Determination of the suitability of the mounting system with respect to
   1. Flexibility properties of the mounts,
   2. Clearances provided, and
   3. Locations of the mounts on the equipments.

   These factors are considered first in importance and can be obtained in sufficiently good approximation with little detailed analysis.

B. Determination of the relative intensity of shock, as to its effect on shock mounted apparatus, as a function of location within a ship and of distance and orientation of the ship with respect to the source of the explosion.

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3. Shock mounted electronic equipment was found to be most suitable for these studies. The most satisfactory condition existed when a given type of gear, mounted in a standard manner, was found on many different ships. This occurred for several types of radio and radar gear. Lead gages were used with these gears and with other equipment where frequency determinations could easily be made or where, for some other reason, the displacements were of particular interest.

Ships Instrumented with Lead Gages

4. As the amount of effort that could be put forth to any particular phase of instrumentation was limited, only the following ships were instrumented with lead gages. These ships were chosen as capable of giving information concerning shock intensity as a function of distance from the bomb, and to a lesser extent, as a function of location within a ship. The few applications in the APA type ships were on equipment especially installed for the Crossroads test. The ships instrumented are listed in Table I.

Table I - Ships Instrumented with "X" or Lead Gages:

Destroyers

DD367 Lamson*
DD389 Mugford
DD390 Ralph Talbot
DD403 Trippe
DD404 Rhind
DD406 Stack
DD408 Wilson
DD410 Hughes
DD411 Anderson*
DD419 Wainwright

Attack Transports

APA57 Gilliam*
APA64 Bracken
APA77 Crittenden
APA79 Dawson

Battleships

BB34 New York

Cruisers

CA24 Pensacola
CA25 Salt Lake City

Submarines

SS184 Skipjack**
SS196 Sea Raven
SS308 Apagon**
SS335 Dentuda

*Sunk during Able test, no test data obtained.
**Sunk during Baker test.

The locations of these ships with respect to the explosion for the Able and Baker tests, are shown on Plates 1 and 2.

Method of Measurement

5. The determination of the maximum displacement of one object with respect to another was made by "Lead Strip" gages, or "X" gages, which consist of a tapered lead angle soldered to a small rigid base, as shown of Figure 1. The lead is about 1/32 inch thick and its length is trimmed to

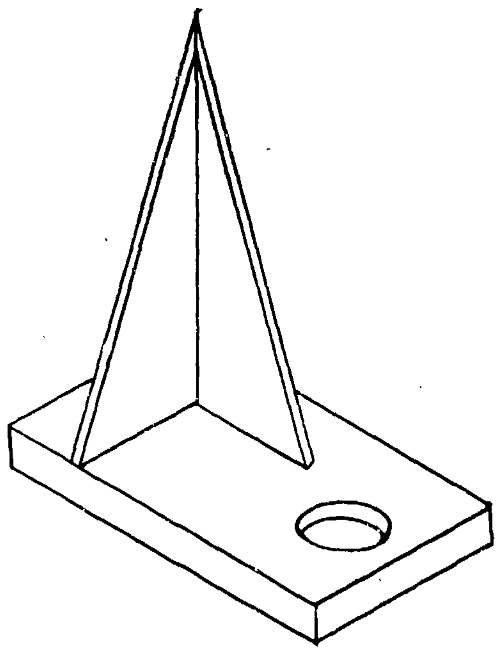


Figure 1 - "X" gage, or tapered lead angle maximum displacement gage.

suit any particular use. The gage is attached so that the relative motions of two parts will crush a portion of the lead angle and so allow the nearest approach of the two parts to be determined. The device is reasonably accurate for sudden velocity changes (for velocities up to about 50 ft/sec) encountered in normal shipboard shock work. The results may be inaccurate because of permanent distortion of a gage support, usually such conditions were easily noticed and the readings were discarded.

Experimental Data and Comments

6. The experimental data together with all information obtained concerning these measurements are tabulated for each target ship involved. The data is complete except for some submarines that were sunk by Baker test and which should provide information of great value if they become available for the determination of instrument recording.

The data usually includes the following:

a. The name and model or type of shock mounted apparatus under study.
b. The name of the ship and the location of this apparatus on the ship.
c. A sketch of the apparatus showing gage locations.
d. Type, location, and clearance of shock mounts used.
e. Identification number of a photograph of the equipment. Some photographs of typical installations are shown on Plate 7.
f. Deflection indicated by each gage. (It is to be noted that each gage identification number contains the number of the ship involved followed by a single number to identify each piece of shock mounted apparatus, and followed by a small letter to designate the gage on a given piece of apparatus.)
g. Notes and comments as may be necessary.

7. The type of mount is often designed as L or C. These are illustrated on Figure 2 below. The C type mounts have fairly linear load deflection curves until they bottom solidly. The L type mounts are fairly linear, for deflections

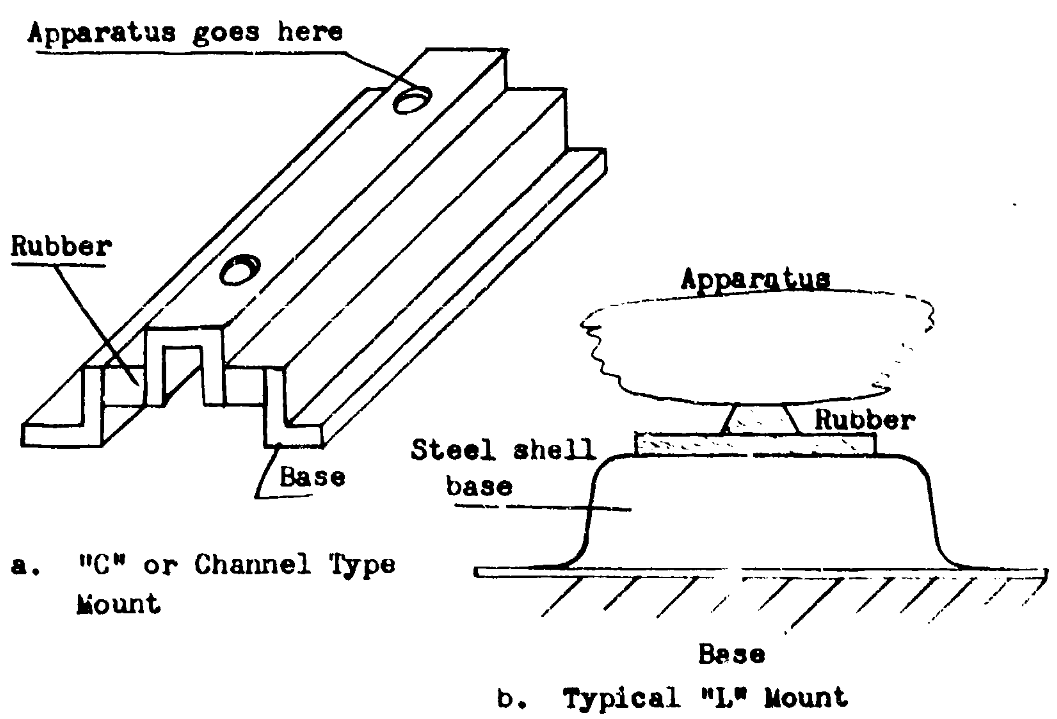


Figure 2 - Principal types of shock mounts.

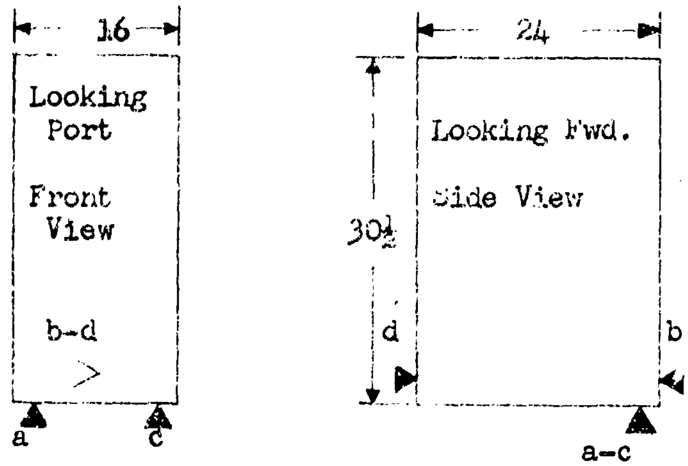
along their axis, until they bottom on their shoulders after which time large compressional restoring forces come into play.

8. There will generally be comments following the individual pieces of apparatus instrumented. There will also be comments at the conclusion of each ship considered which will summarize results for that ship. Finally there will be a general summary and conclusion following the presentation of data.

DD389 MUGFORD

DD389 #1 Gages:

Location: On Radio Transmitter Model TDQ, in Radio Transmitter Room, First Superstructure Deck. The transmitter is in the port side of the room.



Type of Mounting: Short C type mounts on each bottom corner.

Photograph: AA CR 140-2295-2, 3, 4.
AA CR 140-2294-11, 12.

Deflection (inches):

Gage DD389 #1	a	b	c	d
Baker	0.12	0.07	0.11	0.13

The mounting can be assumed to have linear response for these deflections.

Comments

Able: This ship was not instrumented for Able Test.
Baker: The ship was beyond the range of appreciable damaging action of the bomb. There was negligible shock and no appreciable damage of any kind.

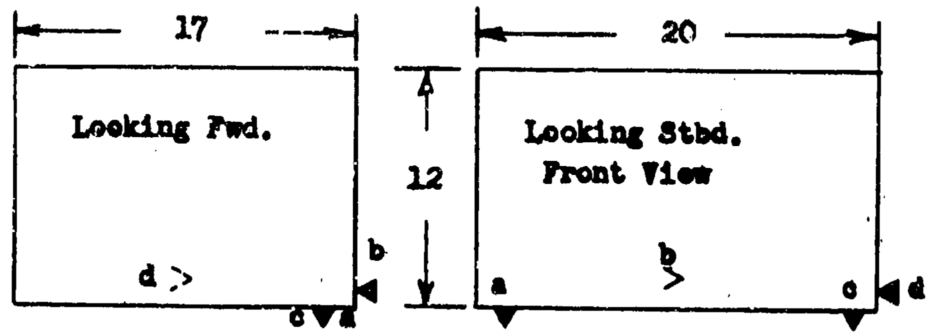
along their axis, until they bottom on their shoulders after which time large compressional restoring forces come into play.

8. There will generally be comments following the individual pieces of apparatus instrumented. There will also be comments at the conclusion of each ship considered which will summarize results for that ship. Finally there will be a general summary and conclusion following the presentation of data.

DD390 RALPH TALBOT

DD390 #1 Gages:

Location: On Radio Receiver Model RBO-2, in Radio Transmitter Room, First Superstructure Deck. The receiver is on the starboard side of the room, above a motor-generator set, and distant from all exterior bulkheads.



Type of Mounting: L type mounts on each of the four bottom corners. Clearance about 3/8 inch.

Photograph: BA CR 95-737-11

Vibration Modes:

Rocking Fore and Aft	6.05 cps
Rocking Athwartship	7.5
Translation Vertical	9.6

Deflection (inches):

Gage DD390 #1	a	b	c	d
Baker	0.15	0.11	0.15	0.03

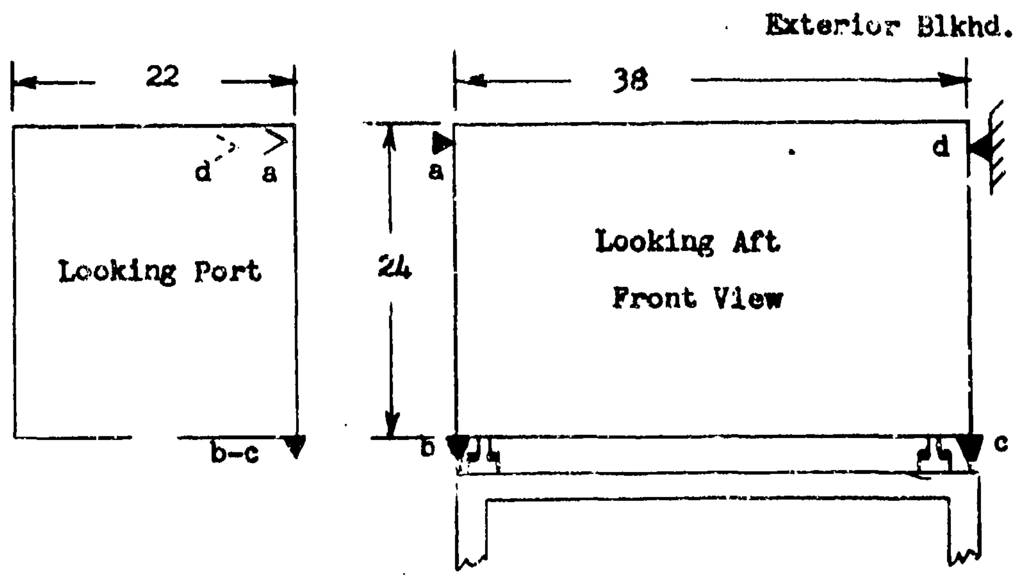
Comments

Able: This ship was not instrumented during Able test.
Baker: There were negligible shock displacements. The ship suffered no appreciable damage.

DD390 #2 Gages:

Location: On Range and Train Indicator Model SG type CRP. In C.I.C. Room which is located on the second superstructure deck.

Top Secret



Type of Mounting: C type mounts on each bottom end run the full depth of the equipment.

Photograph: BA CR 95-737-12

Vibration Modes:

Rocking Fore and Aft	7.6 cps
Rocking Athwartship	11.2

Deflection (inches):

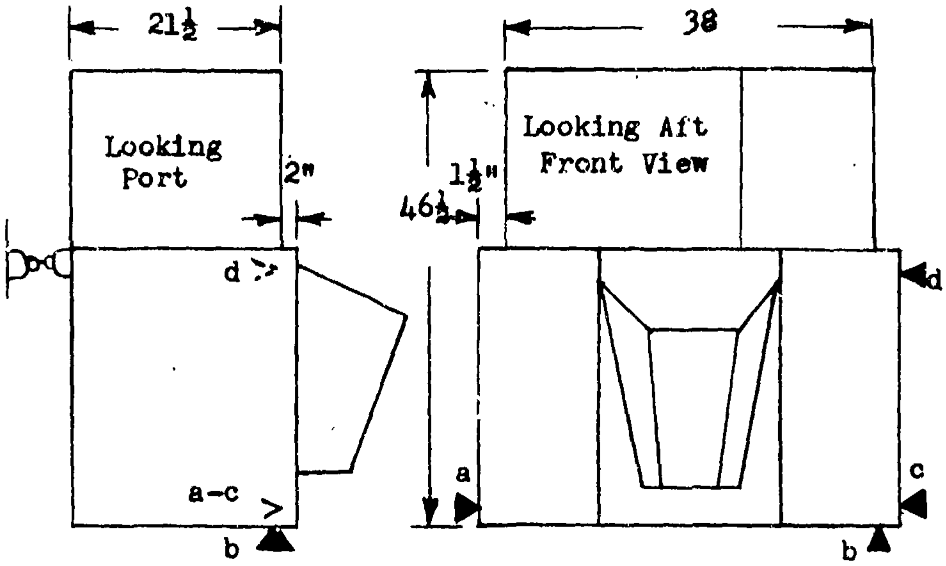
Gage DD390 #2	a	b	c	d
Baker	0.33	0.25	0.11	0.57

Comments

Able: This ship was not instrumented during Able test.
Baker: There was negligible shock and no appreciable damage to the ship or its equipment.

DD390 #3 Gages:

Location: On Plan Position Indicator in C.I.C. Room, Second Superstructure Deck (starboard aft side of room).



Type of Mounting: Short C type mounts on each of the four bottom corners. L type mounts on the upper back corners of the lower unit. Clearance slightly over 1/4 inch for the bottom mounts.

Vibration Modes:

Rocking Fore and Aft	5.7 cps
Rocking Athwartship	4.4

Deflection (Inches):

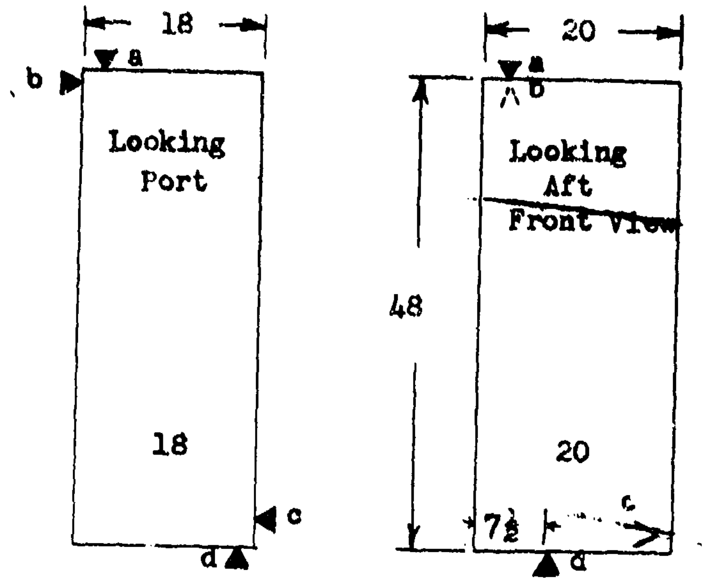
Gage DD390 #3	a	b	c	d
Baker	0.15	0.13	0.57	1.00

Comments

Able: This ship was not instrumented during Able test.
Baker: There was negligible shock and no appreciable damage.

DD390 #4 Gages:

Location: On Radar Transmitter Model SC3 type CG, in Radar Transmitter Room, Second Superstructure Deck. (Near aft bulkhead.)



<u>Type of Mounting</u>: C type mounts on the four bottom corners and on bottom edges between the corners (total eight mounts on bottom). Two C type mounts on the upper back corners. About one inch vertical clearance.

<u>Photograph</u>: BA CR 95-738-2 and BA CR 95-738-3

<u>Vibration Modes</u>:

Rocking Fore and Aft	7.1 cps
Rocking Athwartship	7.4
Translation Vertical	9.7

<u>Deflection (inches)</u>:

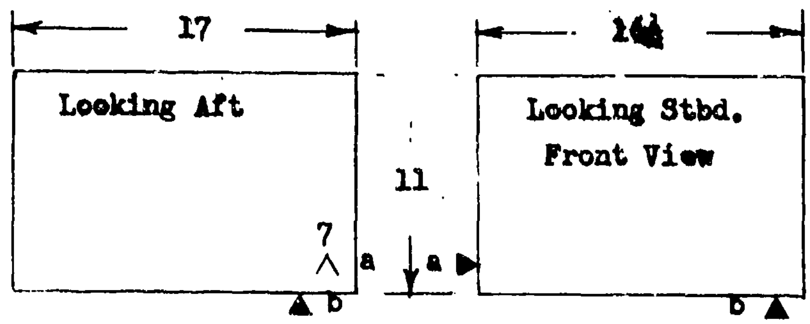
Gage DD390 #4	a	b	c	d
Baker	0.09	1.33	0.07	0.07

<u>Comments</u>

<u>Able</u>: This ship was not instrumental for Able test.
<u>Baker</u>: There was negligible shock and damage. In spite of the negligible shock intensity the displacement of the top of the tall narrow transmitter was 1.3 inches. This indicated the large displacements caused by rocking modes of poorly mounted equipment.

<u>DD390 #5 Gages</u>:

<u>Location</u>: On Model BN Transmitter and Receiver, type CFN-43ACB, in Radar Transmitter Room, Second Superstructure Deck. (Starboard aft corner of room.)



Type of Mounting: L type mounts on four bottom corners. Clearance about 1/8 inch.

Photograph: BA CR 95-738-4

Vibration Modes:

Rocking Fore and Aft	10.1 cps
Rocking Athwartship	11.8
Translation Vertical	21.3

Deflection (inches):

Gage DD390 #5	a	b
Baker	0.13	0.08

DD390 General Discussion

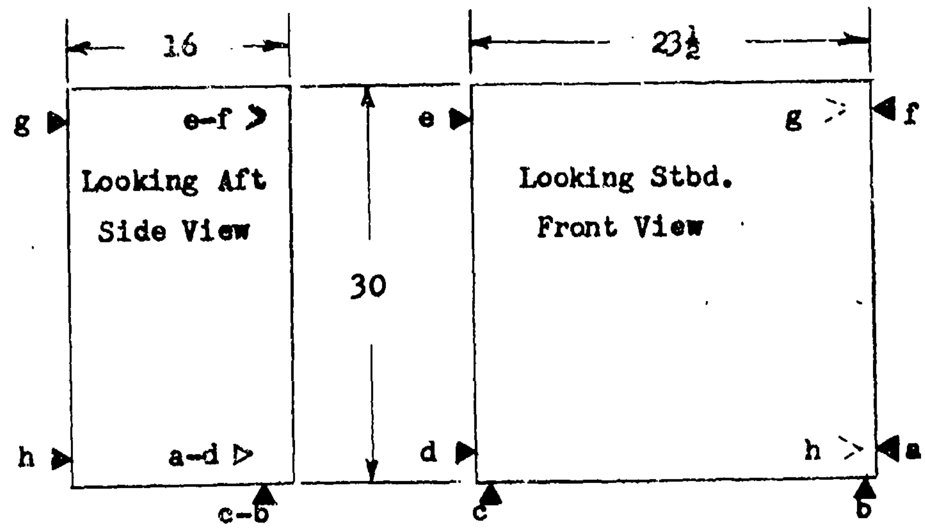
Able: This ship was not instrumented for Able test.
Baker: The ship was beyond the effective range of the bomb. There was negligible shock and damage.

DD403 TRIPPE

Lead gage data was obtained for this ship only for the Baker test.

DD403 #1 Gages:

Location: On Radio Transmitter Model TDQ, in Radio Transmitter Room, First Superstructure Deck. The transmitter is in the starboard side of the room.



Type of Mounting: The unit is mounted in an angle iron frame to which it is attached by means of C type mounts on the four bottom corners.

Photograph: AA CR 140-2293-1

Deflection (inches):

Gage DD403 #1	a	b	c	d	e	f
Baker	0.04	0.16	0.13	0.04	0.15	0.19

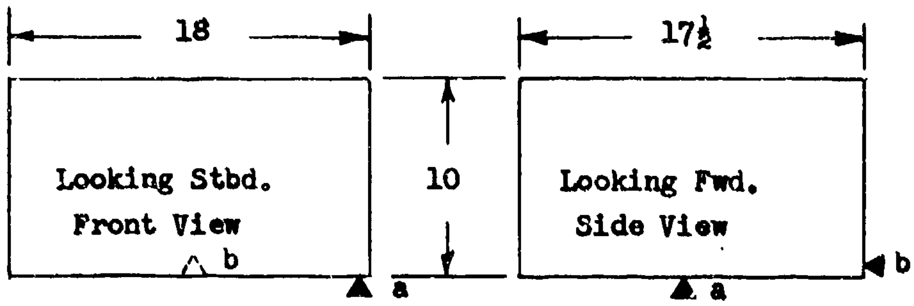
	g	h
	0.40	0.05

Comments

See "General Discussion" for this ship.

DD403 #2 Gages:

Location: On Model RCK Radio Receiver, Radio Transmitter Room, First Superstructure Deck. The unit is located on the starboard side above the TDQ.



Type of Mounting: L type mounts are under on the four bottom corners.

Photograph: AA CR 140-2293-1 and AA CR 140-2293-8

Deflection (inches):

Gage DD403 #2	a	b
Baker	0.12	0.10

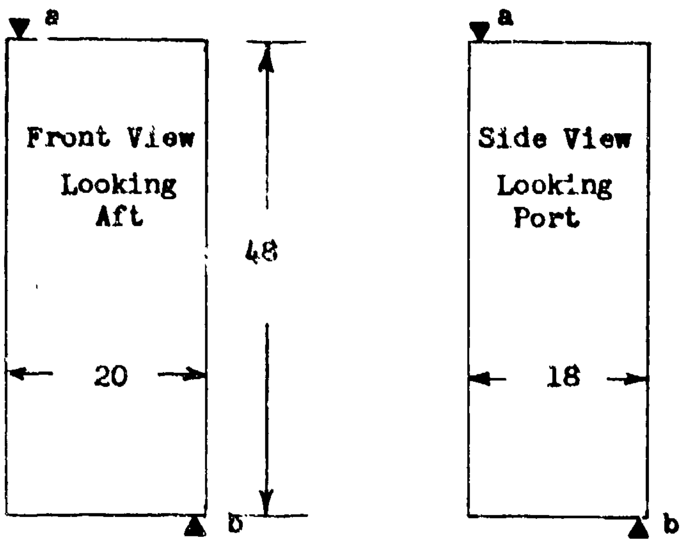
The deflection is about equal to the clearance.

Comments

See "General Discussion" for this ship.

DD403 #3 Gages:

Location: On Radar Transmitter Model SC-3, in Radar Transmitter Room, Second Superstructure Deck. The transmitter is in the aft end of the room.



Type of Mounting: Eight C type mounts equally spaced around the bottom edges. Two C type mounts on two upper back corners.

Photograph: AA CR 140-2292-10, 11, 12.

Deflection (inches):

Gage DD403 #3	a	b
Baker	0.33	0.25*

*Probably bottomed.

Comments

See "General Discussion" for this ship.

DD403 #4 Gages:

Location: On Range and Train Indicator Model SG, in C.I.C. Room, Aft Port Side, Second Superstructure Deck.

Type of Mounting: The long C type mounts, equally spaced across the bottom, run the full depth of the equipment. Clearance over 3/8 inch.

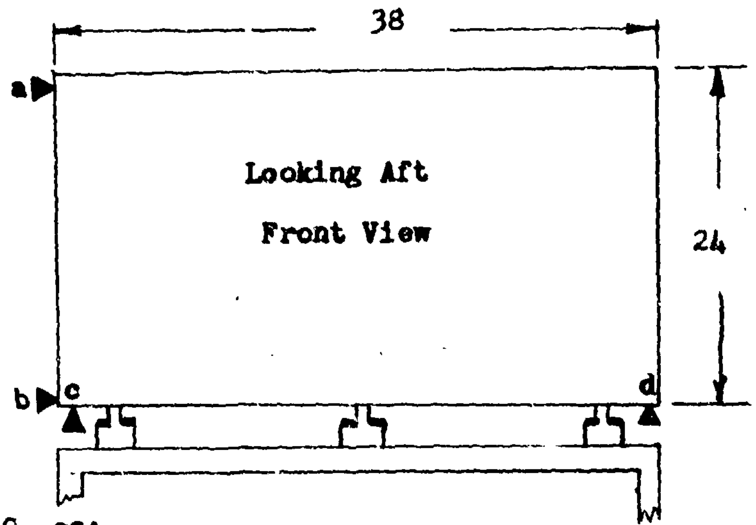
Photograph: AA CR 140-2293-5, 6, 7, 9.

Deflection (inches):

Gages DD403 #4	a	b	c	d
Baker	0.11	0.03	0.21	0.23

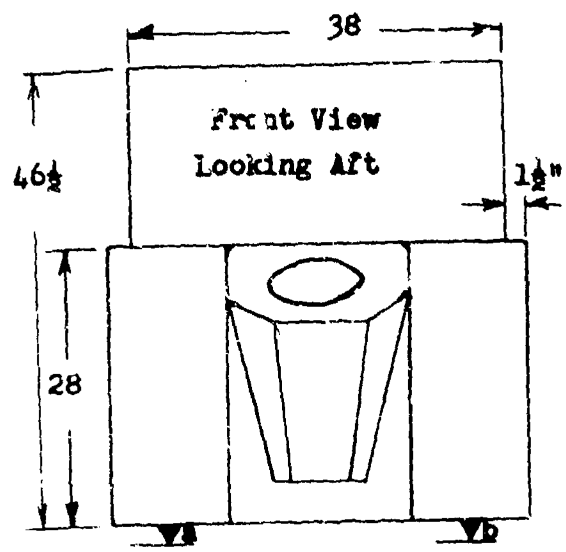
Comments

See "General Discussion" for this ship.



DD403 #5 G.. es:

Location: On Plan Position Indicator, type CG, in C.I.C. Room, Aft Starboard Side, Second Superstructure Deck.



Type of Mounting: Short C type mounts on each of four bottom corners. L type mounts in back upper corners of main unit.

Photograph: AA CR 140-2292-2, 3, 4.

Deflection (inches):

Gage DD403 #5	a	b
Baker	0.26*	0.23

*Probably bottomed.

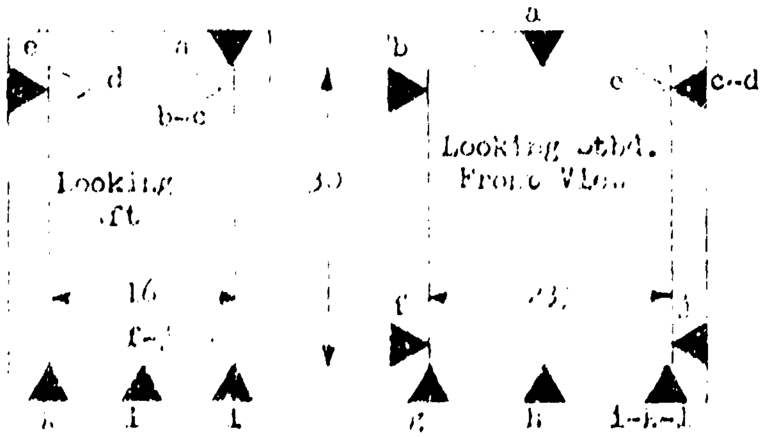
DD403 General Discussion

Baker: The ship was beyond the effective damaging range of the bomb. While no appreciable damage occurred, the shock mounts bottomed in many cases.

DD404 BLAND

DD404 #1 Gages:

Location: On Radio Transmitter Model TDQ, in Radio Central Transmitter Room, First Superstructure Deck. (Starboard side of forward interior bulkhead.)



Type of Mounting: Unit is mounted in an angle iron frame. C type mounts are [illegible] each of the four bottom corners. Vertical clearance is slightly greater than 1/4 inch.

Photograph: [illegible] 95-791-7 and [illegible] 95-79[illegible]-8

Vibration Modes:

Rocking fore and aft	[illegible].7 cps
Rocking athwartship	4.5
Translation Vertical	[illegible]

Deflection (inches):

Gage DD404 #1	a	b	c	d	e	f	g
Able	--	0.56	0.5[illegible]	0.31	[illegible]	0.[illegible]	0.34

	h	i	j	k	l
	0.32	0.40	0.09	[illegible].30	--

Guard bolt [illegible].

Comments:

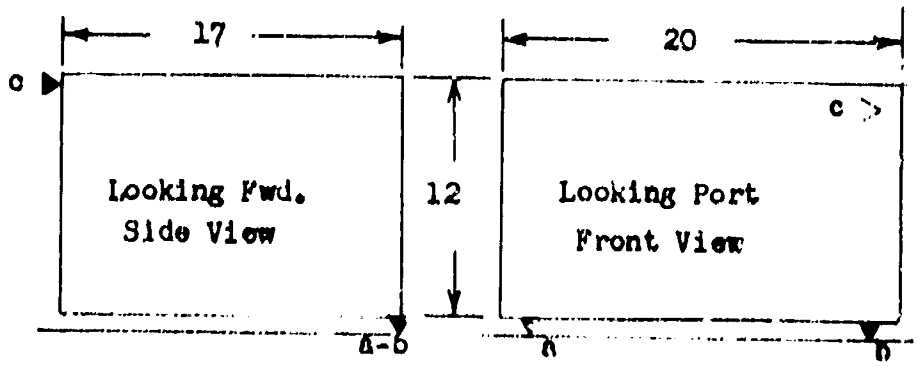
Able: The starboard side of the transmitter room was [illegible] [illegible] [illegible] the [illegible] of the [illegible] angle iron [illegible], the TD, appeared to be in good condition and to [illegible] properly. [illegible] transmitter.

properly. A near by transmitter model TBK had a tube broken and did not key properly.

Baker: No data was obtained for this unit.

DD404 #2 Gages:

Location: On Model RBO Radio Receiver, in Radio Central Receiving Room, First Superstructure Deck.



Type of Mounting: L type mount under each of four bottom corners. Clearance is about 1/4 inch.

Photograph: BA CR 95-791-9

Vibration Modes:

Rocking Fore and Aft	10.6 cps
Rocking Athwartship	8.9
Translation Vertical	11.5

Deflection (inches):

Gage DD404 #2	a	b	c
Able	[illegible]	0.38	0.42
Baker	0.69	0.11	0.19

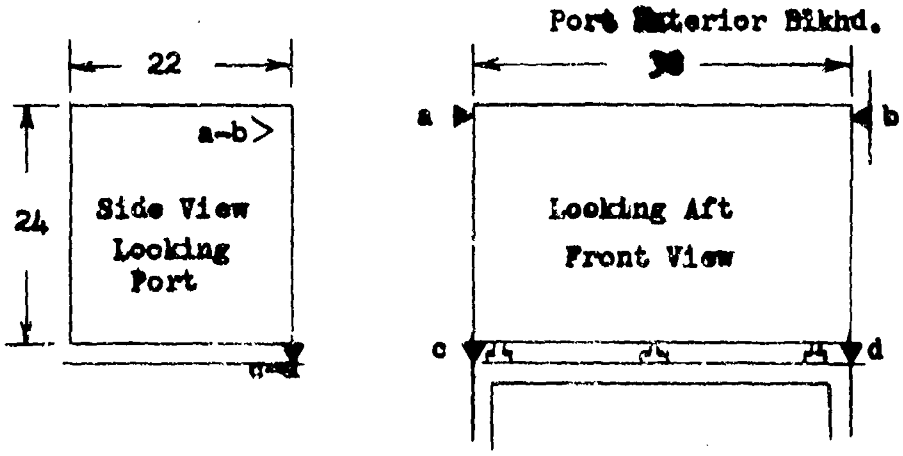
Comments

Able: The mounts bottomed, but the receiver remained in operable condition

Baker: The shock intensity was negligible.

DD404 #3 Gages:

Location: On Range and Train Indicator, in C.I.C. Room, Second Superstructure Deck.



Type of Mounting: Three C type mounts on bottom that extend the full length of equipment. Clearance 1/2 inch.

Vibration Modes:

Rocking Fore and Aft	7.3 cps
Rocking Athwartship	8.2

Deflection (inches):

Gage DD404 #3	a	b	c	d
Able	1.50*	0.75	0.25	0.13
Baker	0.21	0.80	0.10	—

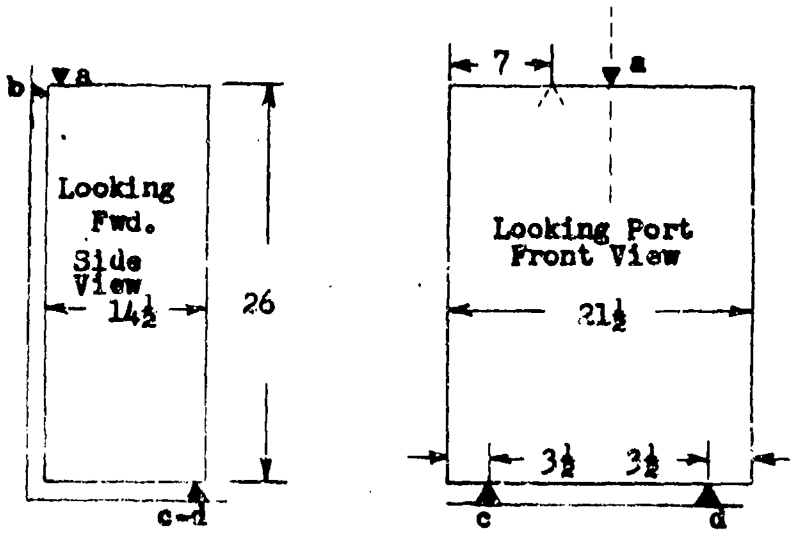
Comments

Able: The entire starboard side of the C.I.C. room was broken open by the blast. The Range and Train Indicator, which was located in the after port side of the room, suffered a considerable horizontal shock, but little vertically. The unit appeared to be in good condition.

Baker: The intensity of shock caused by Baker test was negligible.

DD404 #4 Gages:

Location: On High Voltage Rectifier type CW-20280, in Radio Transmitter Room. Second Superstructure Deck.



Type of Mounting: L type mounts on each bottom corner and on two upper back corners.

Photograph: BA CR 95-791-11

Vibration Modes:
Rocking Athwartship 13.1 cps
(Other modes were much higher and not obtainable)

Deflection (inches):

Gage DD404 #4	a	b*	c	d
Able	0.12	---	0.17	0.18
Baker	0.05	---	0.05	0.06

*Gage knocked off.

Comments

Able: Although the mounts bottomed the intensity of shock did not appear severe. There was no apparent damage to the unit.

Baker: The shock intensity caused by Baker test was negligible.

DD404 General Discussion

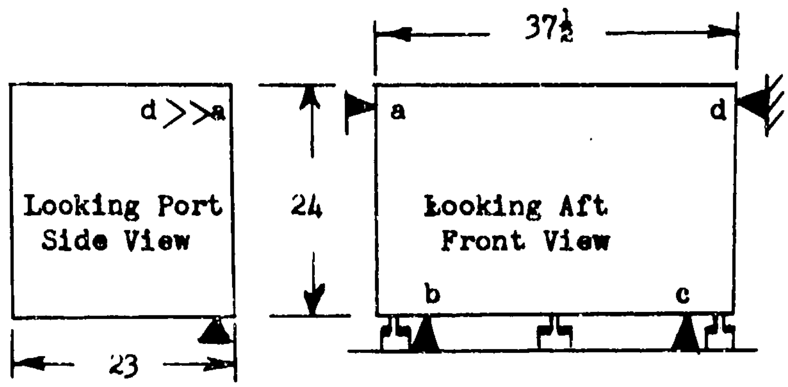
Able: All antenna systems were swept away by the Able blast. Although the blast permanently deformed and broke open some of the bulkheads of compartments containing shock mounted gear there was no evidence of more than moderate intensities of shock.

Baker: The ship was too far removed from the bomb to suffer any appreciable shock damage.

DD406 STACK

DD406 #1 Gages:

Locatic. Range and Train Indicator Model SG, in C.I.C. Room, Second Superstructure Deck. (Port Aft Side.)



Type of Mounting: Three long C type mounts run full depth across the bottom of the equipment. Clearance 1/2 inch.

Photograph: BA CR 95-791-2

Vibration Modes:

Rocking Fore and Aft	20.8 cps
Rocking Athwartship	10.9

Deflection (inches):

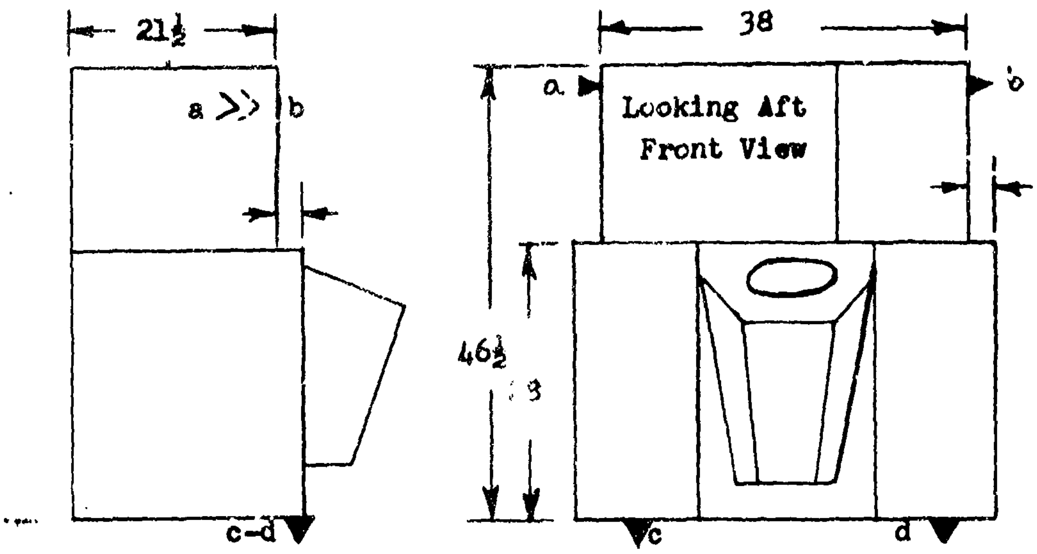
Gage DD406 #1	a	b	c	d
Able	0.50	0.09	0.09	0.94
Baker	0.23	0.04	0.07	0.85

Comments

See "General Discussion" for this ship.

DD406 #2 Gages:

Location: On Plan Position Indicator type CG, Starboard Aft Side of C.I.C. Room, on Second Superstructure Deck.



Type of Mounting: Short C type mounts on each of four bottom corners with L type mounts in back upper corners of lower unit. Clearance about 1/4 inch in vertical direction for bottom mounts.

Photograph: BA CR 95-791-3

Vibration Modes:

Rocking Fore and Aft	5.74 cps
Rocking Athwartship	6.53

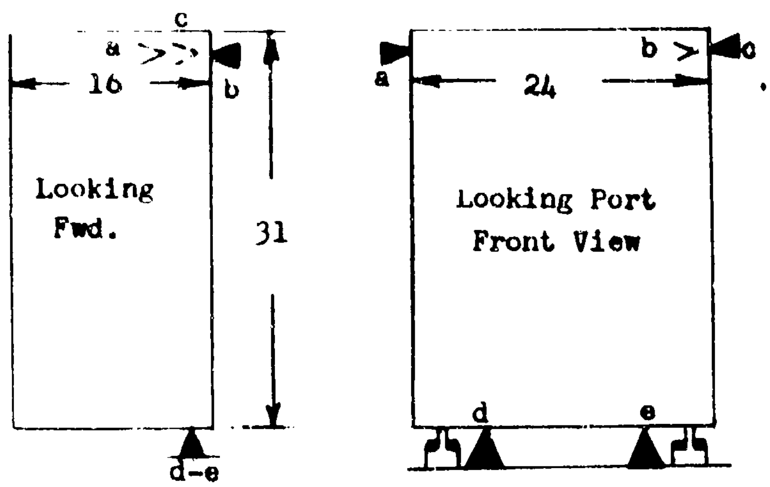
Deflection (inches):

Gage DD406 #2	a	b	c	d
Able	--- *	0.60	0.17	0.09
Baker	0.43	0.43	0.09	0.07

*Bulkhead stiffener next to the a gage was bent in about 3 inches crushing the gage and its support. This stiffener was on a starboard exterior bulkhead. The compartment was undamaged except for the above mentioned distortion.

DD406 #3 Gages:

Location: On Radio Transmitter Model TDQ, in Radio Transmitter Room on Second Superstructure Deck.



Type of Mounting: C type mounts are used on each of four bottom corners. Clearance about 1/4 inch.

Photograph: BA CR 95-791-6

Vibration Modes:

Rocking Fore and Aft	7.6 cps
Rocking Athwartship	4.3
Translation Vertical	11.8 (estimate)

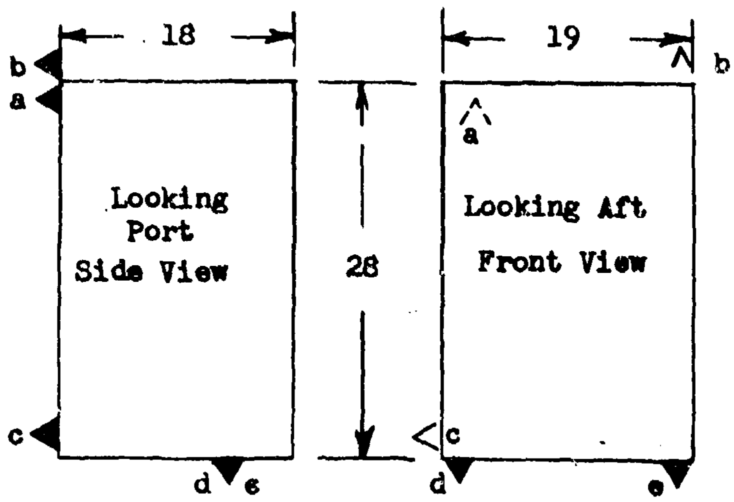
Deflection (inches):

Gage DD406 #3	a	b	c	d	e
Able	0.30	1.4*	0.42	0.23	0.25
Baker	0.10	1.0*	0.16	0.21	0.25

*Gages crushed to full length.
The mounts bottomed.
Compartment and equipment not damaged.

DD 406 #4 Gages:

Location: On Radio Transmitter Receiver type CFN, in Radar Transmitter Room, Second Superstructure Deck.



Type of Mounting: L type mounts are on the four bottom corners. Clearance 1/8 to 1/4 inch to shoulder.

Photograph: BA CR 95-791-4

Vibration Modes:

Rocking Fore and Aft	5.5 cps
Rocking Athwartship	5.9
Translation Vertical	15.3

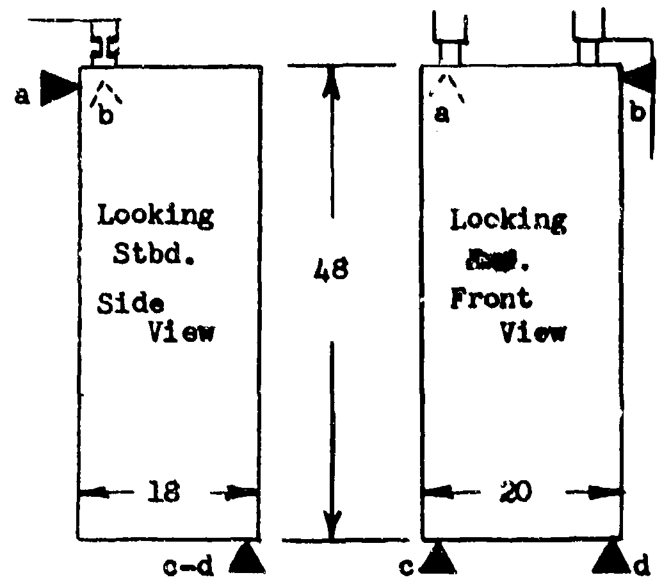
Deflection (inches):

Gages DD406 #4	a	b	c	d	e
Able	0.30	0.30	0.07	0.34	0.22
Baker	0.07	0.10	0.05	0.10	0.17

No apparent damage to compartment.

DD406 #5 Gages:

Location: On Radar Transmitter Model SC2, in Radar Transmitter Room, Second Superstructure Deck.



<u>Type of Mounting</u>: Eight C type mounts are located on the bottom corners and edges. Two C mounts are located on the upper back corner. There is about 1/4 inch vertical clearance.

<u>Photograph</u>: BA CR 95-791-5

<u>Vibration Modes</u>:

Rocking Fore and Aft	10.9 cps
Rocking Athwartship	8.8
Translation Vertical	10.9

<u>Deflection (inches)</u>:

Gage DD406 #5	a	b	c	d
Able	0.17	0.34	0.05	0.0
Baker	0.12	0.17	0.10	0.10

<u>DD406 General Discussion</u>

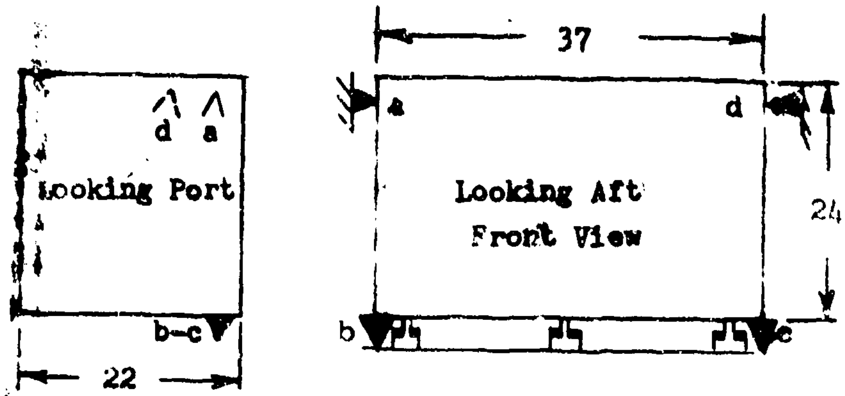
<u>Able</u>: The blast was sufficiently severe to slightly deform some of the exposed bulkheads of the radio compartments. However, the shock intensity was not great. No mounts failed although there was considerable bottoming. In general the electronic gear was not damaged.

<u>Baker</u>: The intensity of shock caused by Baker test was less than that caused by Able for this ship. No damage and little bottoming occurred.

DD408 WILSON

DD408 #1 Gages:

Location: On Range and Train Indicator type CRP in C.I.C. Room, Second Superstructure Deck (Aft port side of room).



Type of Mounting: Three C type mounts, as shown, extend full depth of equipment. Clearance before bottoming is about 1/4 inch.

Photograph: BA CR 95-789-3

Vibration Modes:

Rocking Fore and Aft	7.6 cps
Rocking Athwartship	10.2

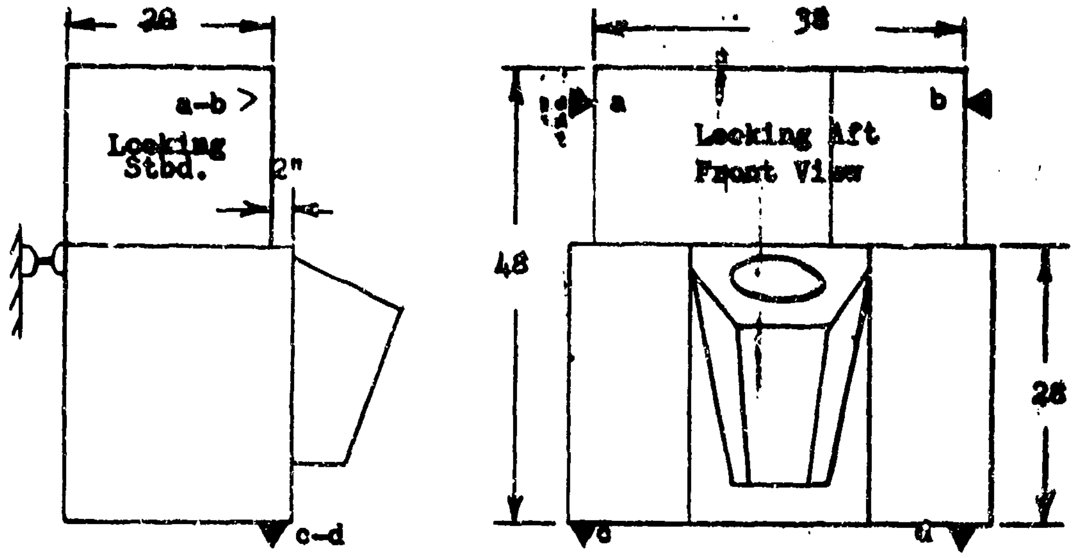
Deflection (inches):

Gage DD408 #1	a	b	c	d
Able	0.36	0.09	0.10	0.17
Baker	0.32	0.05	0.16	0.46

The starboard bulkhead was pushed in several inches by the Able shot, otherwise there was no observable damage.

DD408 #2 Gages:

Location: On Plan Position Indicator type CG, in C.I.C. Room, Second Superstructure Deck (starboard aft corner of the room).



Type of Mounting: Short C type mounts under each bottom corner, and L type mounts in back upper corners of the lower unit. Clearance to bottom about 1/4 inch.

Photograph: DA CR 95-789-4

Vibration Modes:

Rocking Fore and Aft	5.6 cps
Rocking Athwartship	5.7

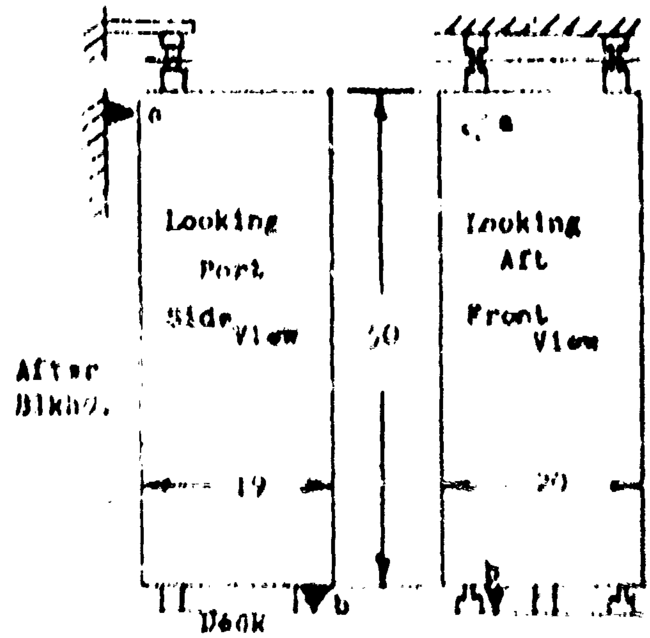
Deflection (inches):

Gage DD408 #2	a	b	c	d
Able	1.2*	0.7	0.12	0.15
Baker	0.5	0.5	0.13	0.11

*This deflection was mostly due to the displacement of the starboard exterior bulkhead to which it was fastened; the permanent displacement of this bulkhead at this point was about 1 inch.

DD408 #3 Gages:

Location: On Radar Transmitter Model SC-3, in Radar Transmitter Room, Second Superstructure Deck (located near center of Aft bulkhead).



Type of Mounting: Six short C type mounts under base plus two head braces on upper back edge. Clearance is about 1/4 inch before mounts bottom.

Photograph: BA CN 95-790-3

Vibration Modes:

Rocking Fore and Aft	9.2 cps
Rocking Athwartship	8.8

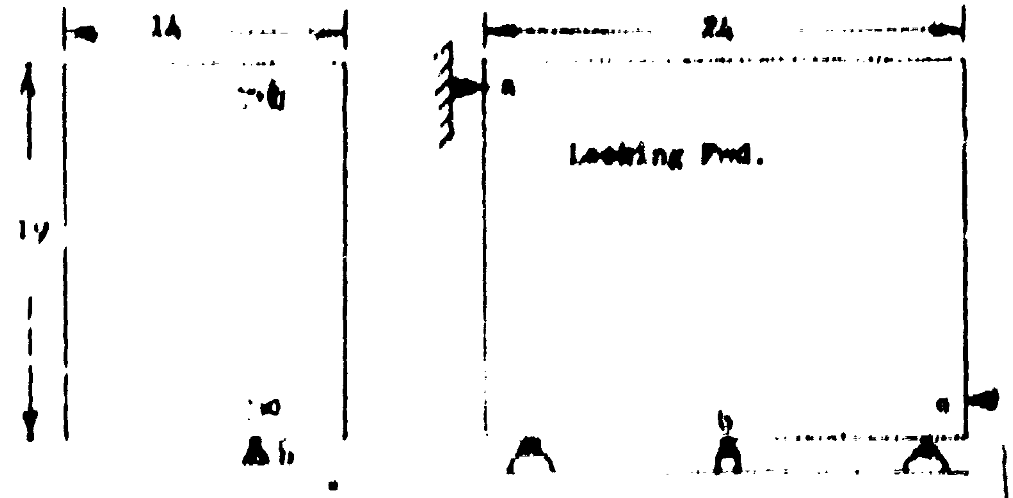
Deflection (inches):

Gage DD408 #3	a	b
Able	0.18	0.09
Baker	0.19	0.16

No noticeable damage for either test. The deflections are less than would be caused by a sustained acceleration of 2 g.

DD408 #4 Gages:

Location: On Auto-Dryaire Model 2200, in Radar Transmitter Room, Second Superstructure Deck.



Type of Mounting: L type mounts on four bottom corners. About 0.30 inches clearance before bottoming on shoulder of mount.

Photograph: BA CN 93-790-4

Vibration Modes:

Rocking Fore and Aft	8.8 cps
Rocking Athwartship	11.8
Translation Vertical	17.0

Deflection (Inches):

Gage [illegible]	a	b	c
Able	0.21	0.17	0.17
Baker	0.45	0.14	0.13

Gage #3 Usage:

Location: On Model TBQ Radio Transmitter, in Main Radio Transmitter Room, First Superstructure Deck. (In forward starboard corner.)

Type of Mounting: O type mounts under each bottom corner. Clearance about 0.2 inches before bottoming.

Photograph: BA CN 93-789-1

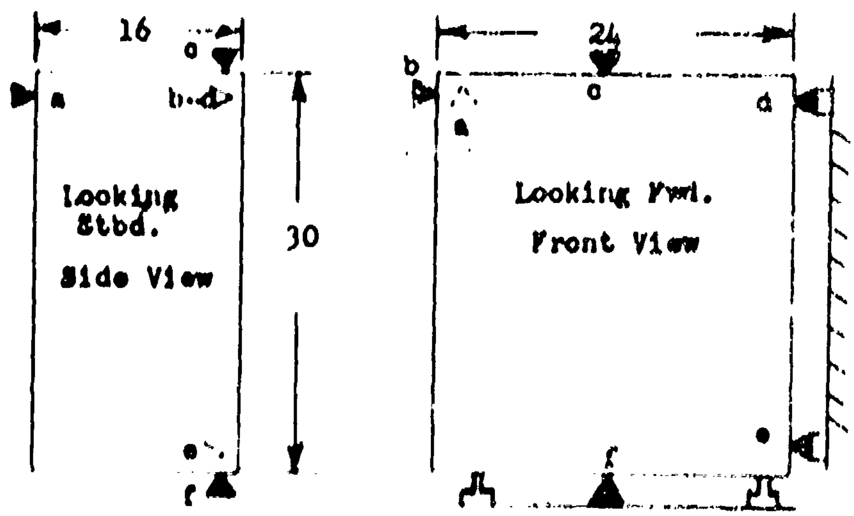
Vibration Modes:

Rocking Fore and Aft	5.1 cps
Rocking Athwartship	6.8
Translation Vertical	12.0 (estimate)

Deflection (inches):

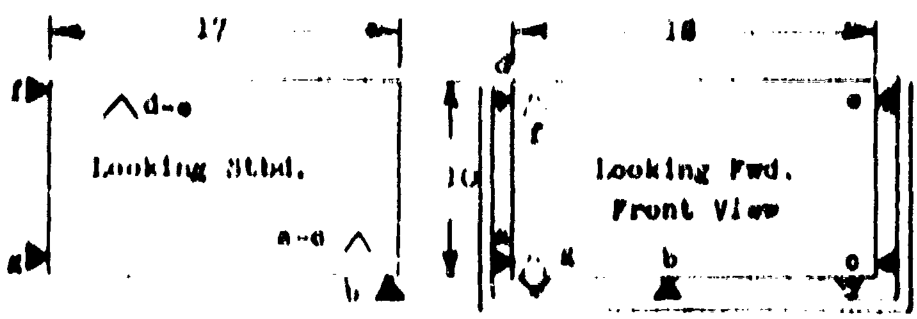
Gage DD406 #5	a	b	c	d	e	f
Able	0.60	0.38	0.18	1.0*	0.60	0.15
Baker	0.21	0.24	0.17	0.37	0.41	0.10

*Bumped against base of gage.
Door casing to compartment was bent in several inches by Able blast.
Radio and radar equipment are in good condition.



DD406 #6 Gages:

Location: On Model RCK Radio Receiver, of Forward Starboard Corner, in Main Radio Transmitter Room, First Superstructure Deck.



Type of Mounting: L type mounts on four bottom corners. Clearance 1/8 to 1/4 inches to shoulder of mounting.

Photograph: BA CR 95-788-12, BA CR 95-789-2

Vibration Modes:

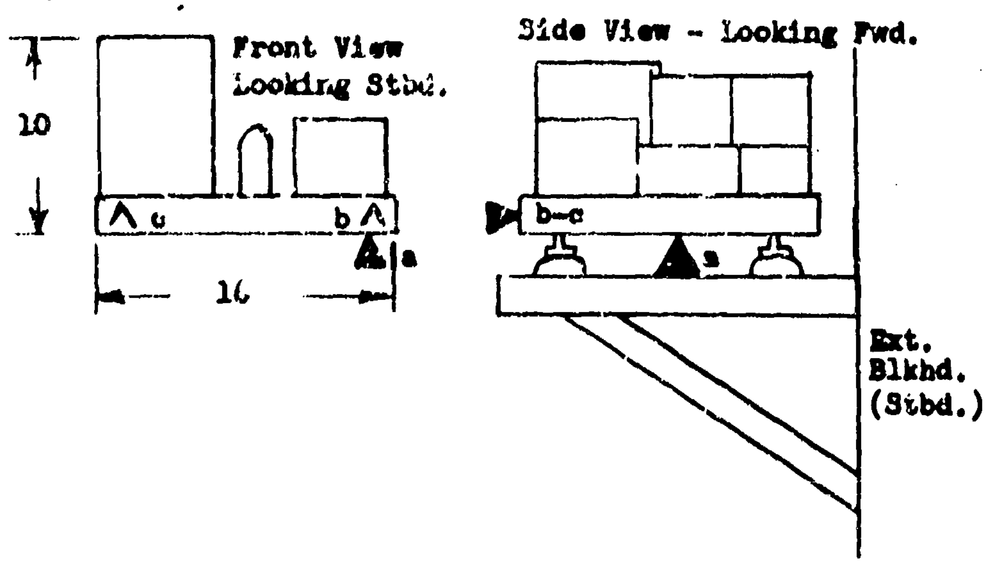
Rocking Fore and Aft	7.[illegible] cps
Rocking Athwartship	9.6
Translation Vertical	12.1

Deflection (inches):

Gage DD408 #6	a	b	c	d	e	f	g
Able	0.08	0.13	0.08	0.10	0.26	0.10	0.09
Baker	0.07	0.10	0.06	0.13	0.18	0.10	0.08

DD408 #7 Gages:

Location: On Power Pack, in Radio Receiving Room, First Superstructure Deck.



Type Of Mounting: L type mounts under four bottom corners. Clearance to shoulders of mounts about 1/8 inch.

Photograph: BA CR 95-788-11

Vibration Modes:

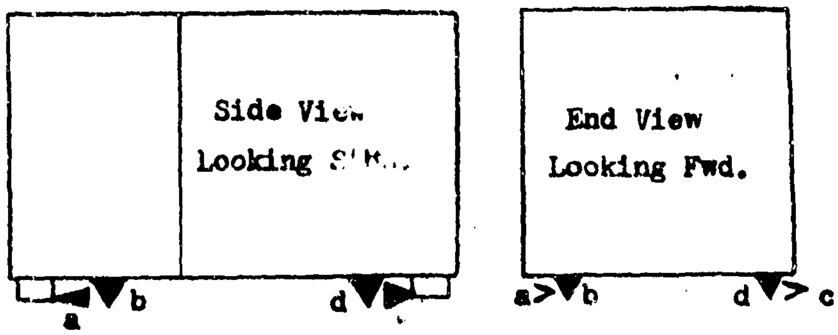
Rocking Fore and Aft	13.3 cps
Rocking Athwartship	11.6
Translation Vertical	12.2

Deflection (inches):

Gage DD408 #7	a	b	c
Able	0.32	0.28	0.14
Baker	0.08	0.05	0.03

DD408 #8 Gages:

Location: On Emergency Diesel Generator, in Compartment A-206-E (frame 56, deck below main deck).



Type of Mounting: Rubber mounts in compression. Less than 1/8 inch clearance laterally.

Photograph: BA CR 140-400-4, 5

Deflection (inches):

Gages DD408 #8	a	b	c	d
Able	0.03	0.02	0.02	0.03
Baker	0.09	0.09	0.0	--

The diesel generator was quite rigidly mounted. No knowledge was obtained of the detailed properties of its supports. No damage was suffered by the equipment.

DD408 General Discussion

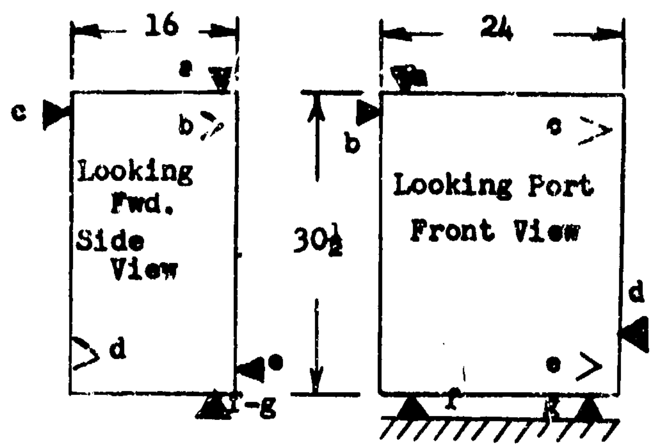
Able: The blast pushed in for several inches some of the starboard bulkheads of the radio and radar compartments. The shock intensity, however, was not great. There were no shock mount failures, although there was some bottoming, and, the equipment generally remained in operable condition. The overall damage to the ship was slight.

Baker: There was no appreciable damage caused by the Baker test. The effect of the Able and Baker shocks on the gear considered was about the same for the two conditions.

DD410 HUGHES

DD410 #1 Gages:

Location: On Model TDQ Radio Transmitter, in Radio Transmitter Room (forward port corner near exterior bulkhead), First Superstructure Deck.



Type of Mounting: C type mounts on four bottom corners. Clearance about 1/4 inch.

Photograph: BA CR 95-737-6

Vibration Modes:

Rocking Fore and Aft	4.4 cps
Rocking Athwartship	6.8
Translation Vertical	11.7

Deflection (inches):

Gage DD410 #1	a	b	c	d	e	f	g
Able	0.21	0.15	0.80	0.07	0.07	0.23	0.21
Baker	Room badly damaged by Baker, no readings possible.						

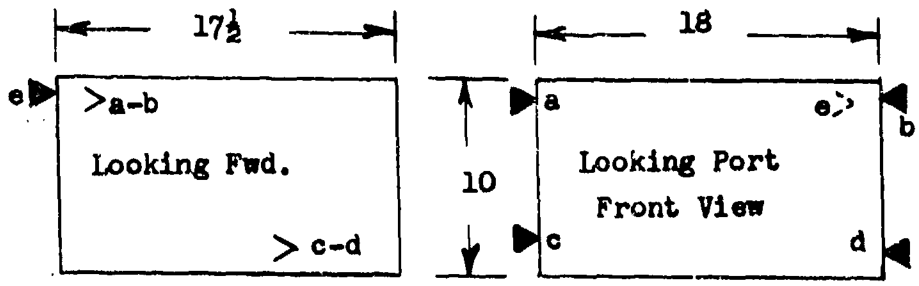
Comments

Able: There was negligible shock or damage caused by test Able.

Baker: The shock caused by Baker test was of great severity. The transmitter room and its contents were in such disorder that no quantitative measurements were possible.

DD410 #2 Gages:

Location: On Model RCK Radio Receiver, in Radio Transmitter Room, First Superstructure Deck. (In Forward Port Corner above TDQ.)



Type of Mounting: L type mounts on four bottom corners. Clearance to shoulders of mounts is 1/8 inch.

Photograph: BA CR 95-737-7

Vibration Modes:

Rocking Fore and Aft	9.3 cps
Rocking Athwartship	8.3
Translation Vertical	11.8

Deflection (inches):

Gage DD410 #2	a	b	c	d	e
Able	0.33	0.23	0.09	0.09	0.25
Baker	Room badly damaged by Baker test, no readings possible.				

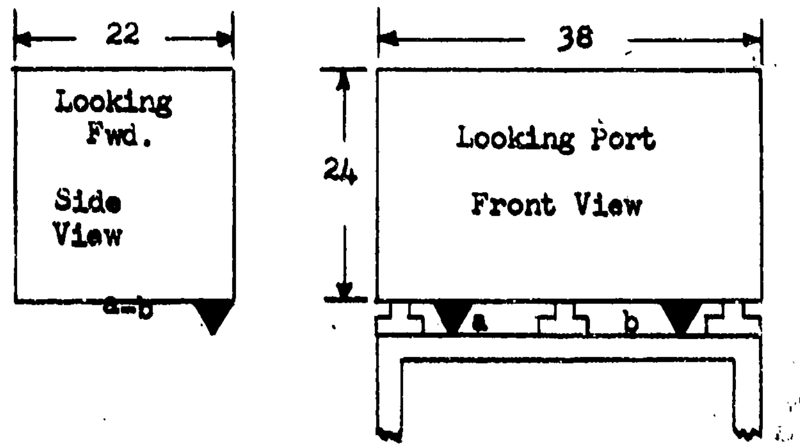
Comments

Able: There was negligible shock or damage caused by test Able.

Baker: The transmitter room and its contents were put in such disorder by the Baker test that no readings were possible.

DD410 #3 Gages:

Location: On Range and Train Indicator type CRP-55ABC-3 Room, Second Superstructure Deck (port side).



Type of Mounting: Three C type mounts, as shown, run the full depth of the equipment. Clearance is about 1/2 inch.

Photograph: BA CR 95-737-8

Vibration Modes:

Rocking Fore and Aft	6.6 cps
Rocking Athwartship	9.1

Deflection (inches):

Gage DD410 # 3	a	b
Able	0.30	0.24
Baker	--*	0.63

*Gage broke off

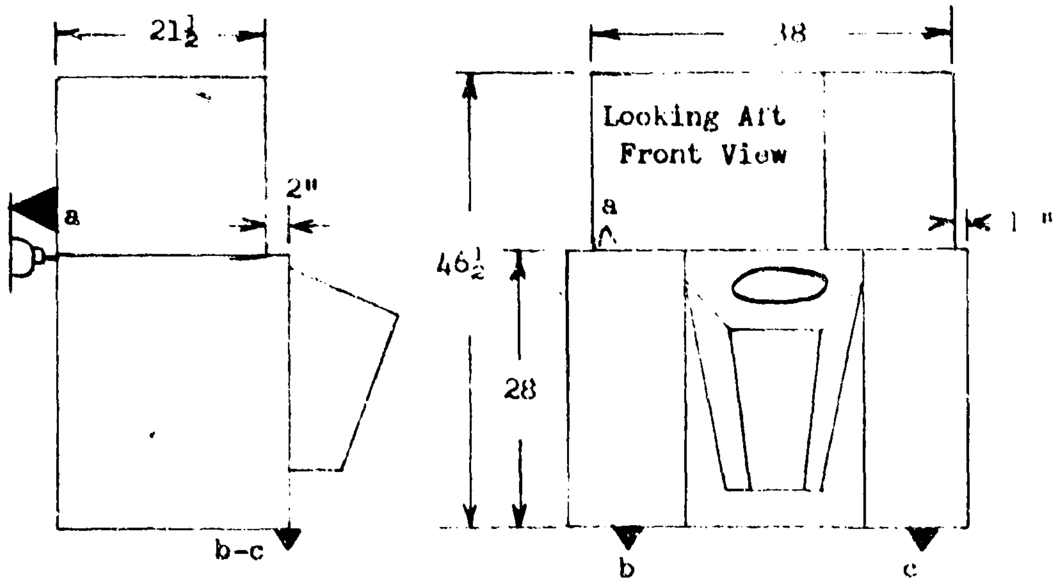
Comments

Able: There was negligible shock or shock damage caused by test Able.

Baker: The shock caused by Baker test was very severe. The mounts did not fail although they were not stiff enough to be effective.

DD410 #4 Gages:

Location: On Plan Position Indicator type CG, in C.I.C. Room (after starboard corner), Second Superstructure Deck.



Type of Mounting: Short C type mounts on each of four bottom corners. L type mounts on the back upper corners of the lower unit. Clearance from 1/4 to 3/8 inch before mounts bottom.

Photograph: BA CR 95-737-9

Vibration Modes:

Rocking Fore and Aft	4.5 cps
Rocking Athwartship	5.0

Deflection (inches):

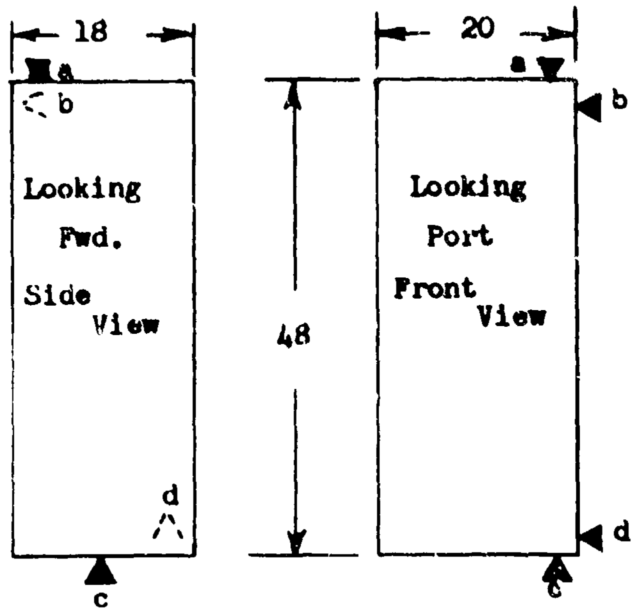
Gages DD410 #4	a	b	c
Able	0.55	0.21	0.09
Baker	--	--	--

Comments

Able: The deflections caused by test Able were small.
Baker: The unit was knocked entirely free of its supports during test Baker. All mounts on the base of the equipment failed. The upper rear mounts pulled a bulkhead "T" section loose.

DD410 #5 Gages:

Location: On Radar Transmitter Model SC-2, type CG, in Radar Transmitter Room, Second Superstructure Deck.



Type of Mounting: Short C type mounts on four bottom corners and in middle of front and back bottom edges. C type mounts on upper back corners. Vertical clearance less than 1/8 inch (rubber had crept).

Photograph: BA CR 95-737-10

Vibration Modes:

Rocking Fore and Aft	7.2 cps
Rocking Athwartship	7.3
Translation Vertical	7.4

Deflection (inches):

Gages DD410 #5	a	b	c	d
Able	0.21	0.25	0.09	0.11
Baker	--	--	--	--

Comments

Able: Only small deflections and no damage were caused by test Able.

Baker: All of the mounts failed for test Baker, allowing the gear to become loose. The compartment was wrecked.

DD410 General Discussion

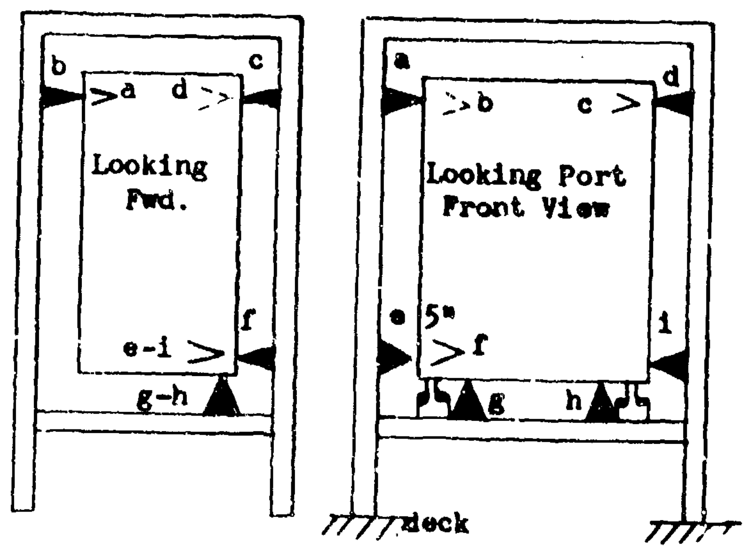
Able: There was no appreciable damage and shock caused to this ship by test Able.

Baker: The ship was severely damaged by test Baker. Considerable flooding and machinery damage occurred. Shock damage to electrical equipment was especially extensive in the lower parts of the ship. The shock experienced by equipment should be regarded as of an intensity slightly less than that which would cause uncontrollable flooding throughout the major part of the ship with a crew present. Watertight integrity was affected principally by the rupture of piping and fracture of sea connections and was not caused by extensive hull failure. It is probable that properly mounted and constructed electrical and electronic gear could withstand the shock existing in the upper parts of the ship. It is apparent that the failure of the machinery items in the lower parts of the ship point to much more attention to be required for their more rugged construction. It is believed that the shock intensity in this case represents a near maximum for which protection is required.

DD419 WAINWRIGHT

DD419 #1 Gages:

Location: On Radio Transmitter Model TDQ, in Forward Port Corner of Radio Transmitter Room, First Superstructure Deck.



Type of Mounting: Short C type mounts on each of four bottom corners. Clearance of mount is about 1/4 inch vertically.

Photographs: BA CR 95-788-6 and BA CR 95-788-8

Vibration Modes:

Rocking Fore and Aft	5 cps
Rocking Athwartship	7.4
Translation Vertical	11.9

Deflection (inches):

Gage DD419 #1	a	b	c	d	e	f	g
Able	0.05	0.46	0.34	0.13	0.05	0.03	0.11
Baker	0.07	0.73	0.50	0.05	0.00	0.03	0.18

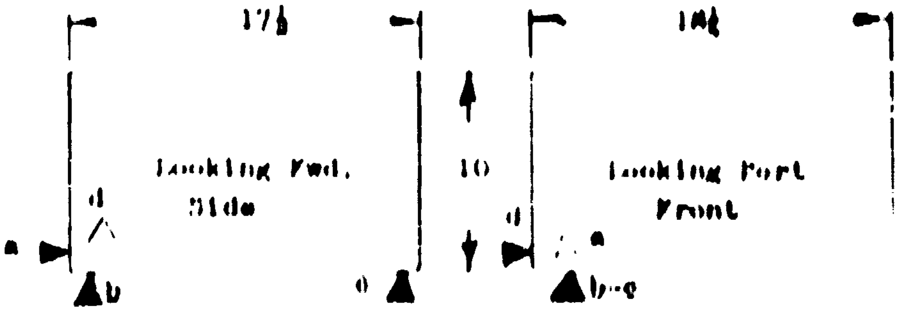
	h	i
Able	0.11	0.00
Baker	0.16	0.00

Comments

See "General Discussion" for this ship.

DD419 #2 Gages:

Location: On Model MCK Radio Receiver, in Forward Port Corner of Radio Transmitter Room, First Superstructure Deck.



Type of Mounting: L type mounts on four bottom corners. Vertical clearance is about 1/8 inch to shoulder of mount.

Photographs: BA CR 95-788-9 and BA CR 95-788-10

Vibration Modes:

Rocking Fore and Aft	10.7 cps
Rocking Athwartship	14.5
Translation Vertical	16.1

Deflection (inches):

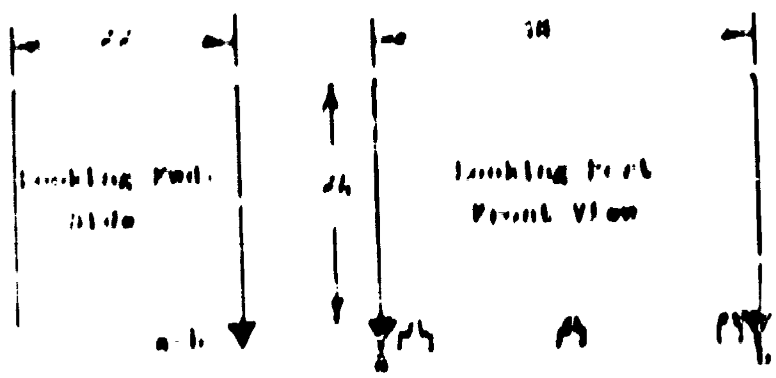
Gage DD419 #2	a	b	c	d
Able	0.01	0.07	0.07	0.01
Baker	0.01	0.06	0.06	0.00

Comments

See "General Discussion" for this ship.

DD617 #3 Gages:

Location: On Range and Train Indicator Model RU, in Aft Port Corner of C.I.C. Room, Second Superstructure Deck.



Type of Mounting: Three long C type mounts, spaced as shown, extend across the full depth of equipment. Vertical clearance of mount is about 1/2 inch.

Photograph: NA CN 95 788 5

Vibration Modes:

Rocking Fore and Aft	20 cps
Rocking Athwartship	8.6

Deflection (inches):

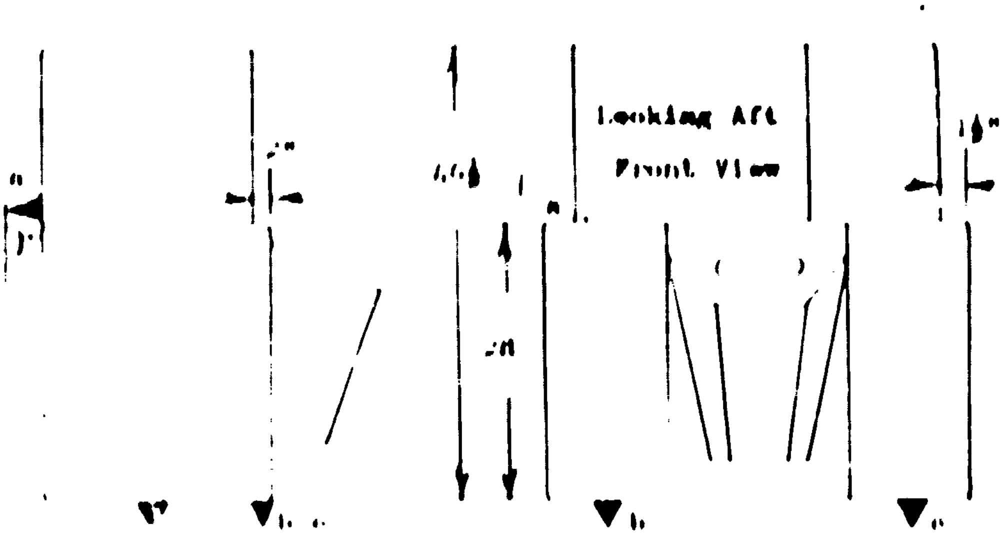
Gage DD617 #3	a	b
Side	0.11	0.11
Base	0.07	0.07

Comments

See "General Discussion" for this ship.

DD617 #4 Gages:

Location: On Plan Position Indicator type CU, on After Starboard Side of C.I.C. Room, Second Superstructure Deck.



Type of Mounting: Short C type mounts on each four bottom corners. C type mounts in back upper corners of lower unit. Vertical clearance is slightly over 1/4 inch for bottom mounts.

Photographs: DA CN 95 700 1 and DA CN 95 700 4

Vibration Modes:

Rocking Fore and Aft	4.4 cps
Rocking Athwartship	4.4

Deflection (Inches):

Gage DD419 #1	a	b	c
Able	0.26	0.11	0.11
Baker	0.41	0.14	0.14

DD417 #2 Gages:

> **Location:** on Radar Transmitter Model SC-1, on Forward Starboard Side of Radar Transmitter Room, Second Superstructure Deck.

Type of Mounting: Eight short C type mounts around bottom corners and edges. Two C type mounts on upper back corners. Vertical clearance of mount is about 1/4 inch.

Photographs: DA CN 95 700 1 and DA CN 95 700 2

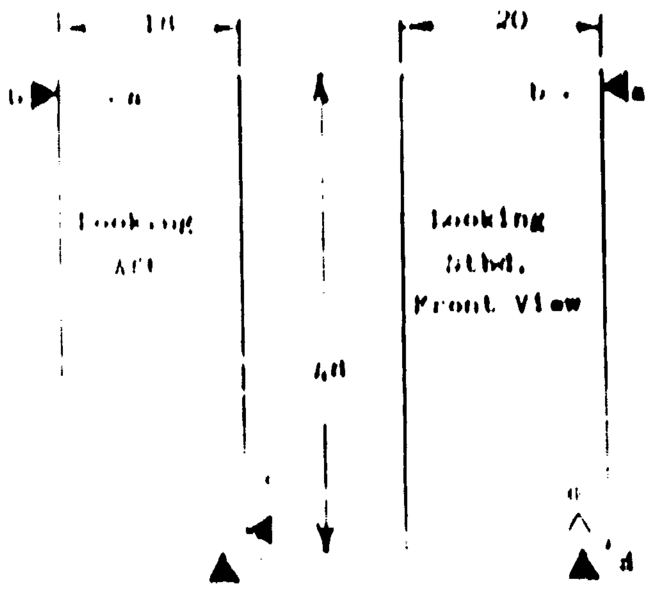
Vibration Modes:

Rocking Fore and Aft — 8.1 cps

Rocking Athwartship — [illegible].6

Deflection (Inches):

Gages DD419 #5	a	b	c	d
Able	0.11	0.09	0.05	0.06
Baker	0.09	0.10	0.13	0.05



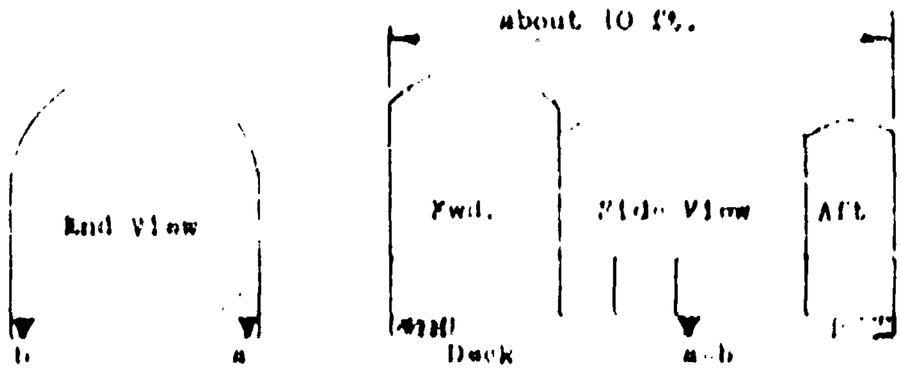
DD419 General Discussion

Able and Baker: There was negligible shock existant on this ship during tests Able and Baker.

APA64 BRACKEN

APA64 #1 Gages:

Location: On Turbo-Generator (BuShips Section 6 [illegible] Special Item #11 #15), in Forward Cargo Hold Lowest Level.



Type of Mounting: The unit is solidly mounted at the four bottom corners, but it has a long unsupported span between the ends. The unit weighs about 15 tons.

Photographs: BA CR 140-1601-10 and BA CR 140-1601-9

Deflection (inches):

Gages APA64 #1	a	b
Able	0.00	0.00
Baker	0.00	0.05

Comments:

Able: There was no measurable deflection of the long unsupported span of the turbo-generator caused by the Able test.

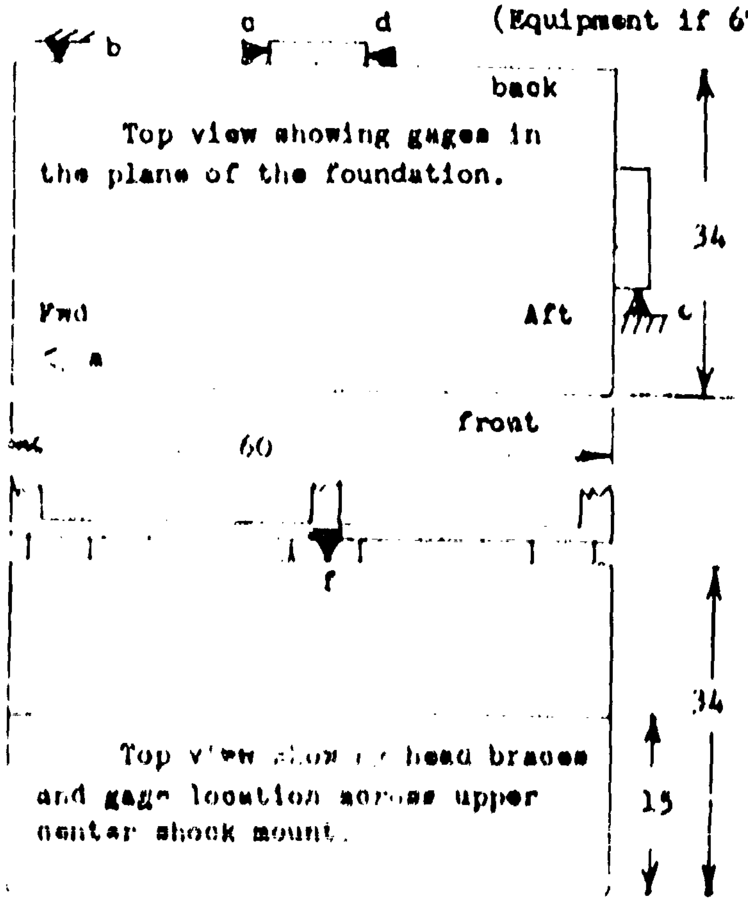
Baker: The deformation of the above mentioned span by test Baker was negligible. The general shock throughout the ship was of a mild nature

APA77 CRITTENDEN

APA77 #1 Gages:

Location: On Control Bench (BuShips Section [illegible] Item 1245), at Starboard Side, Lowest Level, of Forward Cargo Hold.

(Equipment if 67" high)



Type of Mounting: Special built-in mounts using rubber in compression.

Photographs: NA CR 140-1602-1 and NA CR 140-1602-2
NA CR 140-1602-3 and NA CR 140-1602-4

Vibration Modes:

Rocking Fore and Aft	14.1 cps
Rocking Athwartship	11.8

Deflection (Inches):

Gage APA77 #1	a	b	c	d	e	f
Able	0.[illegible]7"	0.19"	0.11"	0.05"	0.12"	0.00"
Baker	0.05	0.02	0.08	0.30	0.00	0.03

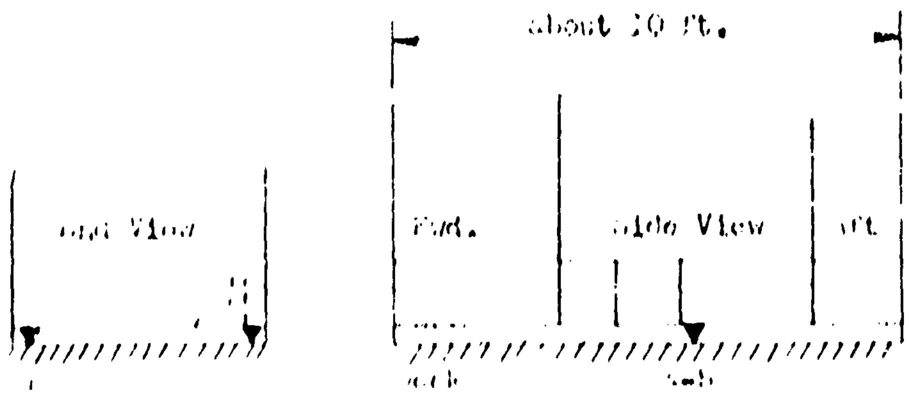
[illegible] Deflection believed caused almost entirely by the impact of falling hatch covers [illegible] at the top of the unit.

Comments

Able: There was no evidence of shock other than that caused by the impacts of falling hatch covers.
Baker: Shock of a very minor nature at this location is indicated by the small deflections of the shock mounted control bench. There was no damage to this gear.

[illegible]77 [illegible] Gages:

Location: On Turbo-Generator (BuShips Section 660 Special Item [illegible]) in Forward Cargo Hold, Lowest Level.



Photographs: [illegible]

[illegible]

[illegible]		
Gage [illegible] 77 [illegible]	[illegible]	[illegible]
Able	[illegible]	0.[illegible]
Baker	0.07	0.11

[illegible] deflection for the Able test is believed caused by the impact of falling hatch covers striking the top of the unit.

[illegible]

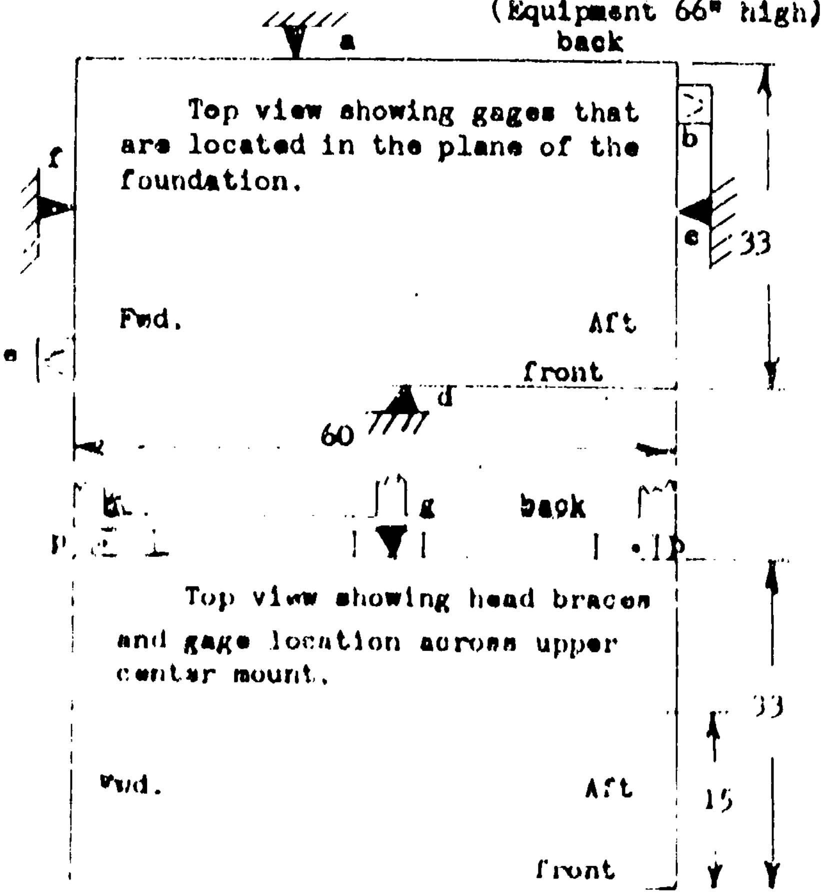
Able: Except for the damage caused by falling hatch covers there were no shock effects caused by Able test.
Baker: The deflection of the long unsupported span of the turbo-generator [illegible] indicated [illegible]

APA79 DAWSON

APA79 #1 Gages:

Location: On Control Bench (BuShips Section 660 Item 13E4) at Starboard Side, Second Platform Deck, in Forward Cargo Hold.

(Equipment 66" high)



Type of Mounting: Special built-in mounts using rubber in compression.

Photographs: BA CR 140-1602-6 through 11

Vibration Modes:
Rocking Fore and Aft — 13 cps
Shear pins prevented other modes of vibration

Deflection (inches):

Gage APA79 #1	a	b	c	d	e	f	g
Able	0.09	0.15	0.05	0.13	0.07	0.05	0.00
Baker	No readings obtained for Baker test.						

Comments

Able: The hatch cover collapsed into this hold and the overhead was bent down over the switchboard. However there was no damage from other causes at the switchboard location or to the switchboard caused by the Able test.

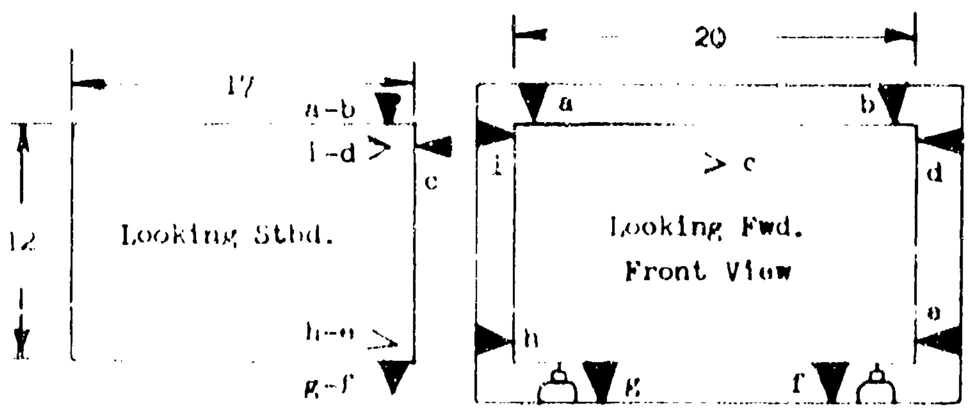
Baker: No data were obtained.

BB34 NEW YORK

There was no appreciable damage, caused by the Able test, to any of the shock mounted equipment internal to the New York. The Baker test, however, resulted in a shock of reasonably severe intensity throughout the ship.

BB34 #1 Gages:

Location: On Model RBO Radio Receiver, in Forward Starboard Corner of Main Radio (Receiving) Room, Third Deck Interior Room between Frames 50-53.



Type of Mounting: L type mounts on the four bottom corners. Clearance is not apparent but is on the order of 3/8 to 1/2 inch. The unit is mounted in an angle iron frame that is attached to a forward interior bulkhead.

Photograph: BA CR 54-752-1

Vibration Modes:

Rocking Fore and Aft	9.1 cps
Rocking Athwartship	10.4
Translation Vertical	11.5

Deflection (inches):

Gage BB34 #1	a	b	c	d	e	f
Able	0.11	0.09	0.05	0.00	0.00	0.07
Baker	0.75*	0.75*	0.05	0.23	0.09	0.23

	g	h	i
Able	0.11	0.01	0.07
Baker	0.19	0.09	0.21

*Gage smashed flat.

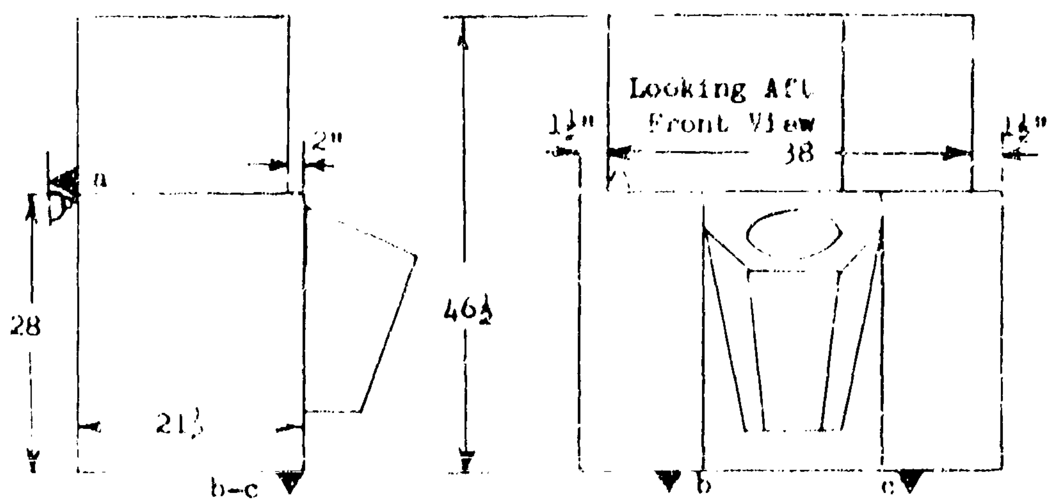
Comments

Able: The shock at this interior part of the ship was negligible. The deflections are generally less than would be caused by a sustained acceleration of 1g.

Baker: The vertical component of the shock was severe causing 3/4 inch upward motion and solid bottoming. However, there was no apparent damage to the receiver. The shock in the horizontal direction was negligible.

BB34 #2 Gages:

Location: On Plan Position Indicator, type CG, in Center of After Bulkhead of C.I.C. Room which is located on the Signal Bridge.



Type of Mounting: Short C type mounts on each four bottom corners. L type mounts on back upper corners of the lower unit. Clearance of mounts is between 1/4 and 3/8 inch.

Photograph: BA CR 54-752-3

Vibration Modes:

Rocking Fore and Aft	3 cps
Rocking Athwartship	4.2

Deflection (inches):

Gage BH34 #2	a	b	c
Able	0.15	0.15	0.15
Baker	— *	— *	— *

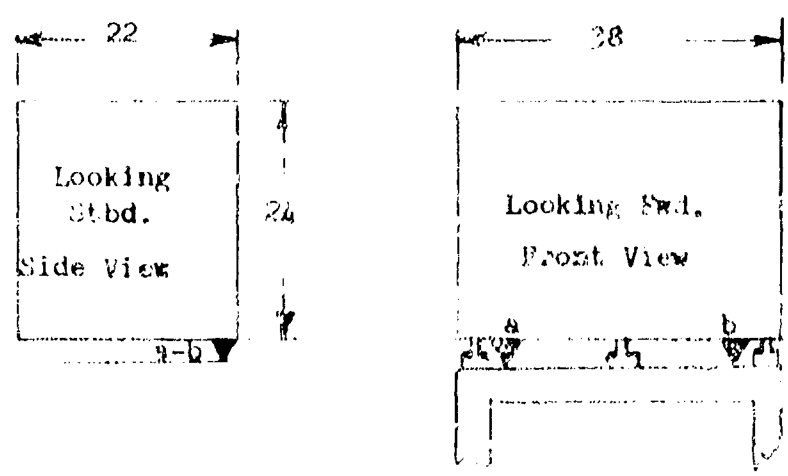
*Equipment broke loose and moved about two feet forward.

Comments

Able: There was no appreciable shock.
Baker: The shock mounts failed and allowed equipment to come loose.

BH 34 #3 Gage:

Location: On Range and Train Indicator, type CMP-55 AFH, in Forward Port Corner of C.I.C. Room on Signal Bridge.



Type of Mounting: Three C type mounts run the full depth of the equipment as shown above. Vertical clearance of mounts is about 1/2 inch.

Photograph: BA CR 95-737-8

Vibration Modes:

Rocking Fore and Aft	7.6
Rocking Athwartship	8.4

Deflection (inches):

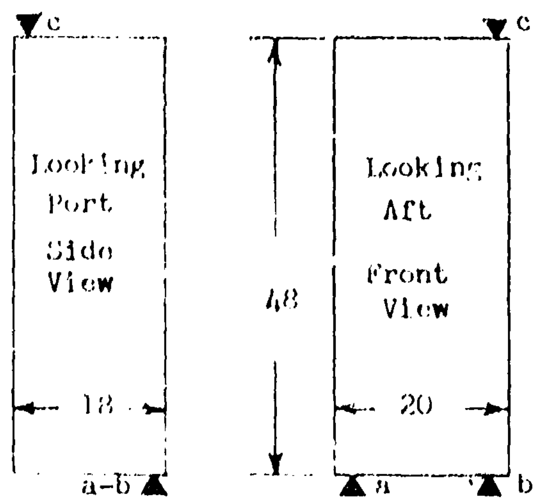
Gage BH34 #3	a	b
Able	0.11	0.15
Baker	0.48	0.34

Comments:

Able: There was no appreciable shock.
Baker: It is probable that the apparatus bottomed, but with little excess energy. If it is assumed, as a reasonable approximation, that the frequency of vertical vibration is 10 cps, then at least 1/2 inch clearance is required. This is about 5 times the static deflection. The equipment was not obviously damaged.

BB34 #4 Gages:

Location: On Radar Transmitter Model SK type CG-52ABH, in #2 Combat (frame 64) on the Flag Bridge.



Type of Mounting: Eight C mounts used on the bottom corners and on edges midway between corners, two C type mounts on upper back corners.

Photograph: BA CR 54-752-5, BA CR 54-752-6, and BA CR 54-752-7

Vibration Modes:

Rocking Fore and Aft	6 cps
Rocking Athwartship	7.2
Translation Vertical	8.2

Deflection (inches):

Gage BB34 #4	a	b	c
Able	0.15	0.11	0.34
Baker	0.36	0.55	0.95

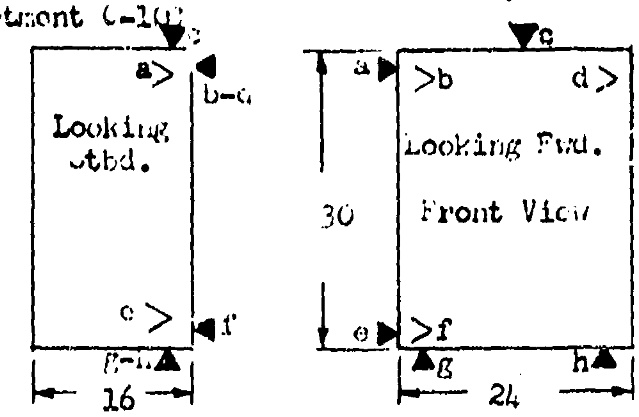
Comments

Able: There was no damage and negligible shock intensity registered by this equipment.

Baker: The mounting system was adequate to protect this radar from noticeable damage. However, the deflections were very large which indicated severe shock conditions.
Type of damage caused by Baker test to Combat #2 compartment is indicated by the failure of the bonding of the sheer mounts (holding the gyro repeater) the train indicator was thrown out of place; and the optical range finder was broken out of the saddle.

BB34 #5 Gages:

Location: On Radio Transmitter Model TDE, in Forward Starboard Corner of Radio Transmitter Room, on the Third Deck, Compartment C-102.



Type of Mounting: Short C type mounts at bottom corners. Clearance to bottom mount is 1/4 inch. The unit is mounted in an angle iron frame.

Photograph: BA CR 95-742-1

Vibration Modes:

Rocking Fore and Aft	4.4 cps
Rocking Athwartship	7.0

Deflection:

Gage BB34 #5	a	b	c	d	e	f	g	h
Able	.01	.09	.13	.07	.01	.01	.17	.19
Baker	.50	.38	.29	.40	.09	.05	.30	.30

Comments

Able: There was no appreciable shock.

Top Secret

Baker: No shock mounted apparatus in this compartment appeared damaged although there was a considerable quantity of equipment, as fans, starting boxes, etc., broken loose from the bulkheads. It is evident that the damaging components of shock involved such small displacements that the clearances of about 1/2 inch provided sufficient protection with the type of mounts used.

BB34 General Discussion

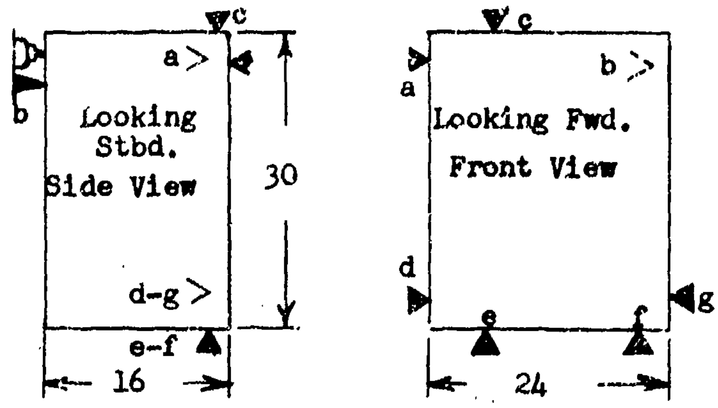
Able: There was no appreciable [illegible] or damage.

Baker: The shock intensity throughout the ship was moderate. The intensity of the low frequency components of shock, as evidenced by the deflections of shock mounted apparatus, was as great on the superstructure decks as on the 3rd deck near the ship's centerline. Except for the failure of the P.P.I. mounting, in the C.I.C. room, the shock mountings proved adequate. There is little doubt but that shock mounted equipment with resonant frequencies no lower than 10 cps, and with mounts located so as to decouple the rocking modes, that 1/2 inch clearance would provide protection for shocks of these types. Equipment that has passed current shock specifications should be well able to withstand these shocks.

CA24 PENSACOLA

CA24 #1 Gages:

Location: On Radio Transmitter, Model TBQ, in Main Radio Room on the Communication Platform.



Type of Mounting: Short C type mounts on four bottom corners, L type mounts on two upper back corners. Vertical clearance to shoulders of mounts is 1/4 inch.

Photograph: BA CR 95-738-5

Vibration Modes:

Rocking Fore and Aft	12.0 cps
Rocking Athwartship	16.4
Translation Vertical	14.4 (some rocking)

Deflection (inches):

Gage CA24 #1	a	b	c	d	e	f	g
Able	.19	.25	.19	.05	.21	.21	.05
Baker	.34	.40*	.41	.09	.35	.35	.09

*Broken

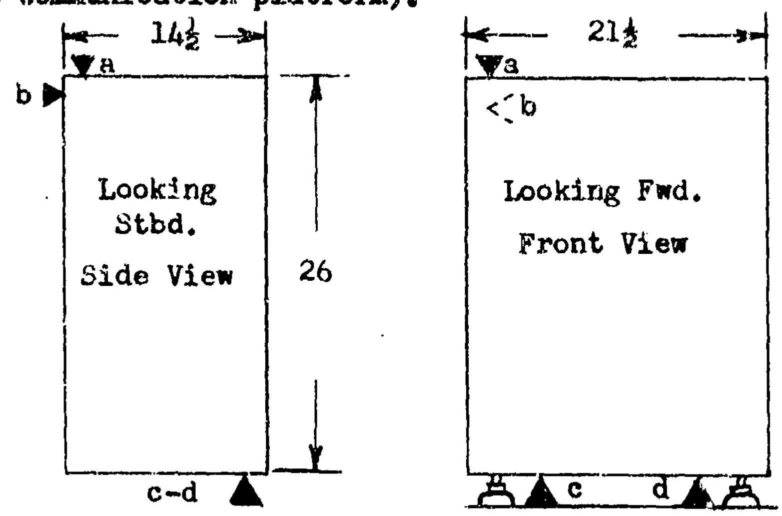
Comments

Able: Although there was very extensive damage just external to this compartment there was no visible damage within. The unit was mounted to the structures that were attached only to the deck. The major shock direction was vertical and the deflection was no greater than would be caused by a sustained acceleration of 5 g. There was no damage to the transmitter.

Baker: There was a much more severe shock resulting from the Baker test than for the Able test. Again the direction of greatest severity at this location was vertical. Although the mounts bottomed there did not appear to be any serious damage to the transmitter.

CA24 #2 Gages:

Location: On High Voltage Rectifier type CW-20280, a Unit of Mark 28 Radar; in Radar Transmitter Room (just above the communication platform).



Type of Mounting: L type mounts on four bottom corners. Clearance to shoulder of mount is about 1/16 inch, however the shoulder is one inch thick.

Photograph: CR 95-738-6

Vibration Modes:

Rocking Fore and Aft	6.7 cps
Rocking Athwartship	9.6
Translation Vertical	20.0

Deflection (inches):

Gage CA24 #2	a	b	c	d
Able	0.30	0.56	0.42	0.42
Baker	Room too damaged to obtain readings.			

Comments

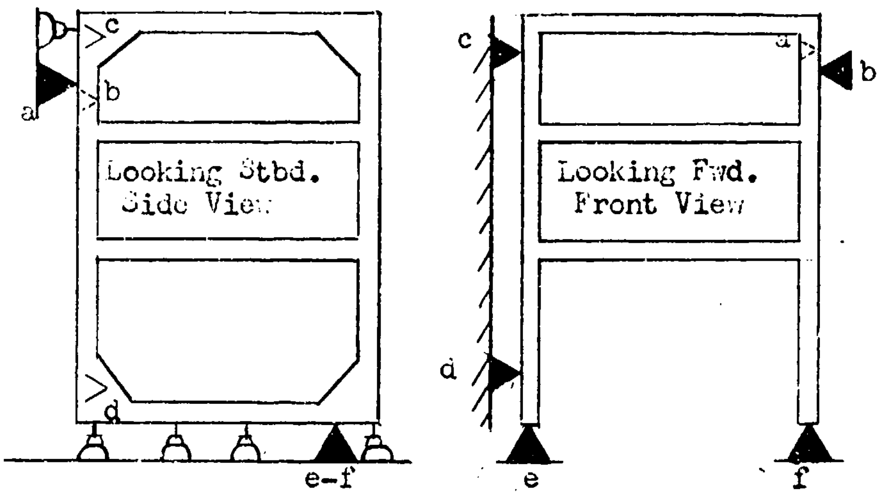
Able: The starboard bulkhead was slightly bent in by the blast, but there was no noticeable damage in the compartment. The shock as indicated by the displacement was severe. The mounts were deflected

vertically to at least 10 times their static load.

Baker: The compartment was severely damaged and was filled with a chaotic mass of loose material.

CA24 #3 Gages

Location: On Shock Mount Rack Containing Fire Control Radar Gear, located on Port Side of Radar Transmitter Room.



Type of Mountings: Four L type mounts under each side bottom edge. The L type mounts on upper back corners. Clearance 1/8 inch to shoulders of mounts.

Vibration Modes:

Rocking Fore and Aft	7.4 cps
Rocking Athwartship	8.0

Deflection (inches):

Gage CA24 #3	a	b	c	d	e	f
Able	0.70	0.75	--*	0.34	0.07	0.09
Baker	Room too damaged to obtain readings.					

*Rubber of upper back shock mount failed.

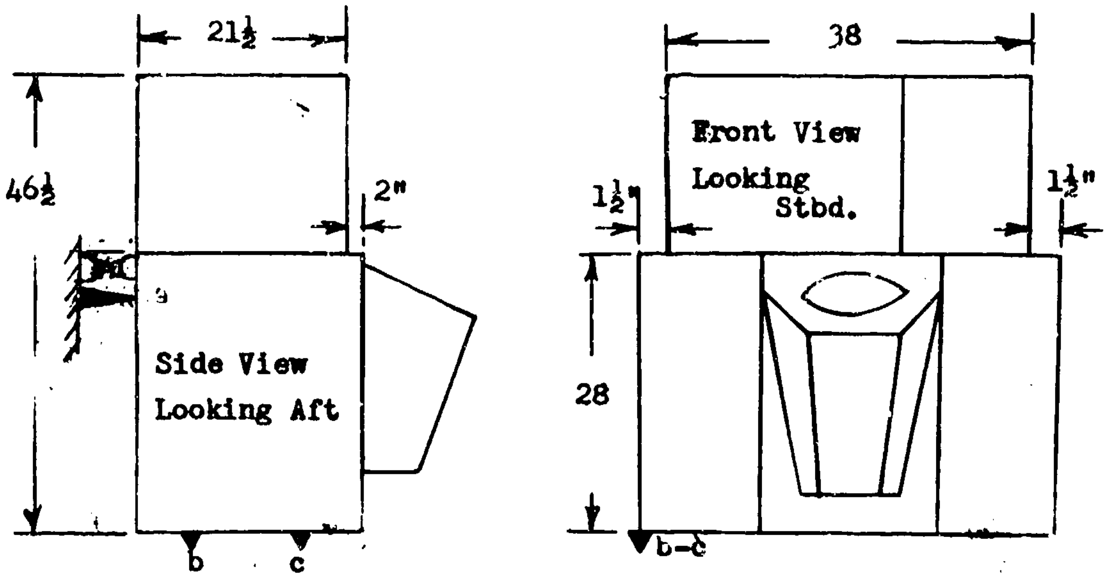
Comments

Able: This apparatus was attached to the deck and to bulkheads. The mounts attached to the bulkhead were strained and one failed. The vertical shock was minor compared with those transmitted by the bulkhead.

Baker: The compartment was in such chaotic condition that no measurements could be made. The Rack was still held in place by the mounts.

CA24 #4 Gages:

Location: On Plan Position Indicator, in C.I.C. Room.



Type of Mounting: Short C type mounts on four bottom corners. L type mounts on upper back corners of main unit. Vertical clearance 1/16 to 1/4 inch.

Photograph: BA CR 95-738-8

Vibration Modes:

Rocking Fore and Aft	4.6 cps
Rocking Athwartship	4.7

Deflection (inches):

Gage CA24 #4	a	b	c
Able	0.62	0.30	0.21
Baker	—	0.50	0.46

Comments

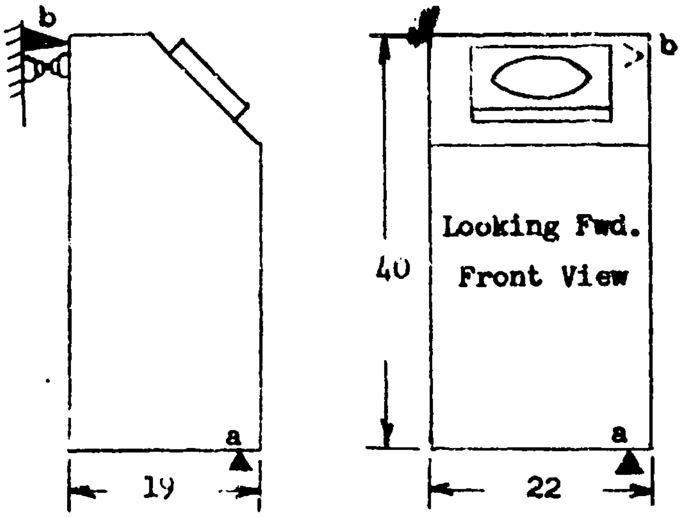
Able: Extensive structural damage existed in the space just forward of the C.I.C. room, but the C.I.C. room and the equipment in it were undamaged.

Baker: Considerable displacements occurred near the top of the P.P.I. as gage a was distorted too greatly for readings. The vertical shock was very severe as there was about 1/2 inch displacement downward

although the clearance was but 1/4 inch. This indicated bending of the structural parts.

CA24 #5 Gage:

Location: Plan Position Indicator type CG-55ADD, Near Center of Forward Bulkhead of C.I.C. Room.



Type of Mounting: Combination mounts on each of four bottom corners. These consist of C type mounts plus a rubber sandwich in parallel. Stabilizing L type mounts are located at upper back corners. Clearances were not determinable.

Photograph: BA CR 95-238-9

Vibration Modes:

Rocking Fore and Aft	15.3
Rocking Athwartship	10.4

Deflection (inches):

Gage CA24 #5	a	b
Able	0.05	0.23
Baker	0.21	1.25

Comments

Able: There was no apparent damage to the P.P.I. or to its mounting supports. The displacements indicate a minor shock.

Baker: The displacements occurring during this test were about 5 times those occurring during the first test. The compression of 1.25 inches of the top mounts is extreme.

CA24 General Discussion

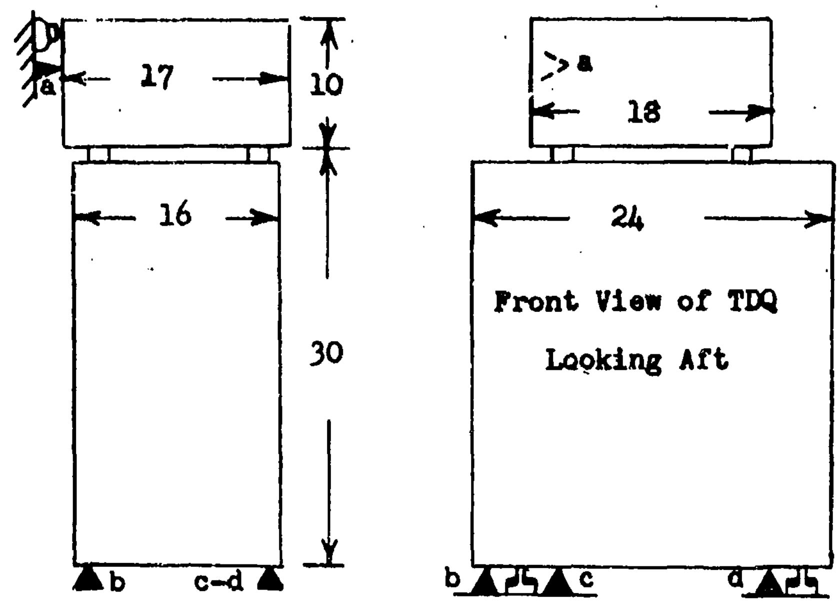
Able: Severe top side structural damage occurred, but inside of closed compartments the shock intensity was moderate for gear attached to decks. When mounts were attached to bulkheads, the shock displacements were large.

Baker: Considerable structural damage, machinery damage, and some flooding were caused by this test. The shock therefore should be considered of moderate intensity but not of the maximum intensity that would occur if the flooding were difficult to control with a crew aboard. The shock mounted apparatus are almost invariably located at points distant from the hull where the intensity of shock is greatly diminished. There is little question but that equipment that passes the Navy "High Impact" shock specifications could easily withstand the shock motions at these locations. In most of the cases where readings were not obtainable the mounts and gear were not seriously damaged. The shock mounted electronic gear was less vulnerable than the ship's machinery to this type of shock damage.

CA25 SALT LAKE CITY

CA25 #1 Gages:

Location: On Model TDQ Radio Transmitter, in Main Radio Station, on Communication Platform (near frame [illegible]).



Type of Mounting: Short C type mounts on four bottom corners. L type stabilizer on top back corners. Clearance of mounts is about 1/8 inch.

Vibration Modes:

Rocking Fore and Aft	5.4 cps
Rocking Athwartship	3.8
Translation Vertical	20.0

Deflection (inches):

Gage CA25 #1	a	b	c	d
Able	0.55	0.25	0.19	0.17
Baker	0.38	0.50*	0.17	0.21

*Doubtful accuracy

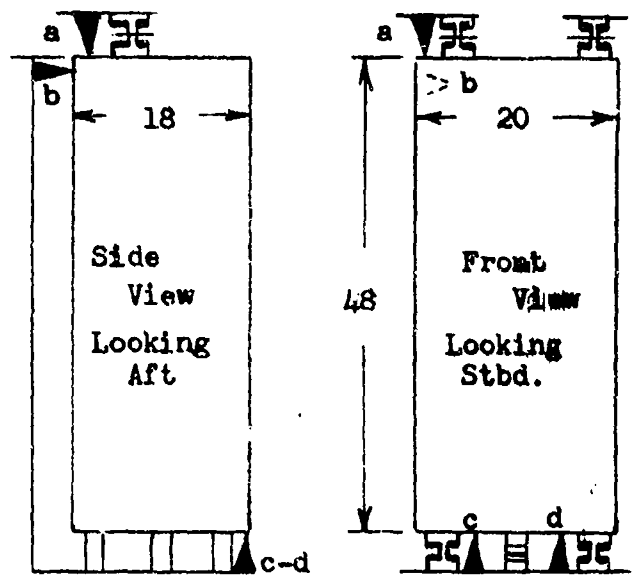
Comments

Able: A shock of sufficient intensity to bottom the mounts occurred, but there resulted no apparent damage to the equipment.

Baker: Except for the deflection of b, the displacements for this test were about the same as for Able. There was no apparent damage to the equipment.

CA25 #2 Gages:

Location: On Radar Transmitter type CG-52ABH, in Radar Transmitter Room (frame 45-47).



Type of Mounting: C type mounts used on four bottom corners and at center of four bottom edges. Two C type mounts are used on the upper back edge. Clearance to bottom 1/4 inch.

Photograph: BA CR 95-738-11

Vibration Modes:

Rocking Fore and Aft	10.6 cps
Rocking Athwartship	8.4
Translation Vertical	9.9

Deflection (inches):

Gage CA25 #2	a	b	c	d
Able	----	----	0.30	0.30

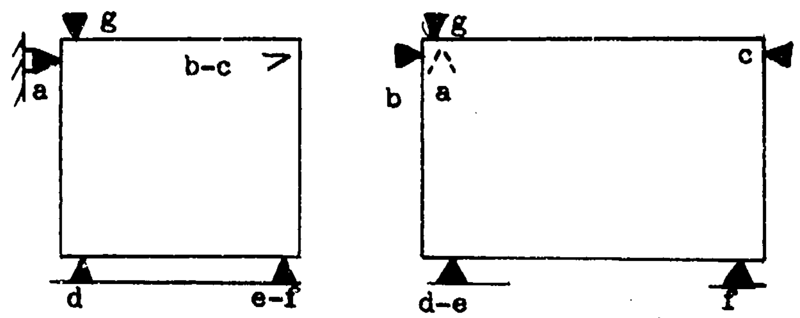
Comments

Able: The top mounts were destroyed. The lower mounts probably bottomed. The general damage within the transmitter room is minor, but the damage outside of the room is very extensive.

Baker: Because of the damage caused by Able test no observations were made for Baker test.

CA25 #3 Gages:

Location: On type CML-50ABH Automatic Gain Control Unit, in Radar Transmitter Room (frames 45-47).



Type of Mounting: L type mounts on four bottom corners. The mounts have collapsed so as to rest on their shoulders. The shoulders can compress 3/8 to 1/2 inch. The unit is mounted in an angle iron frame.

Photograph: BA CR 95-738-12

Vibration Modes:

Rocking Fore and Aft	12.2 cps
Rocking Athwartship	9.8
Translation Vertical	16.7

Deflection (inches):

Gage CA25 #3	a	b	c	d	e	f	g
Able	0.82*	0.50	0.62*	0.62	0.22	0.34	0.34
Baker	---**	---**	0.28	0.30	0.40	0.40	1.10

*Gage crushed, limit of travel.
**Gages broken off.

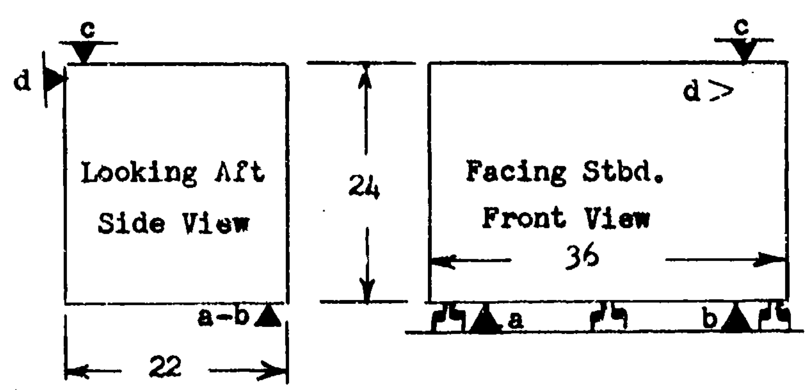
Comments

Able: The unit is in an angle iron frame which was welded to the deck and to an interior bulkhead. The unit collided with this frame indicating large displacements in the 3 principal directions. However, the unit did not appear to be damaged. The transmitter room did not suffer much damage, but damage just outside the compartment was severe. Some tubes in an adjacent transmitter (no shock mounts) were broken.

Baker: The intensity of shock was somewhat greater for Baker than for Able. It should be noted that an identical unit mounted just above the subject one, and on the same angle iron rack, tore loose from its mounts.

CA25 #4 Gages:

Location: On Range and Train Indicator type CRP-55ABC-1 in C.I.C. Room, Superstructure Deck.



Type of Mounting: Three C type mounts, spaced as shown above, extend the full depth of equipment. Vertical clearance of 5/16 inches.

Photograph: BA CR 95-739-1

Vibration Modes:

Rocking Fore and Aft	24 cps
Rocking Athwartship	8.3

Deflection (inches):

Gage CA25 #4	a	b	c	d
Able	0.13	0.11	0.46	0.62
Baker	0.30	0.25	1.60	0.50

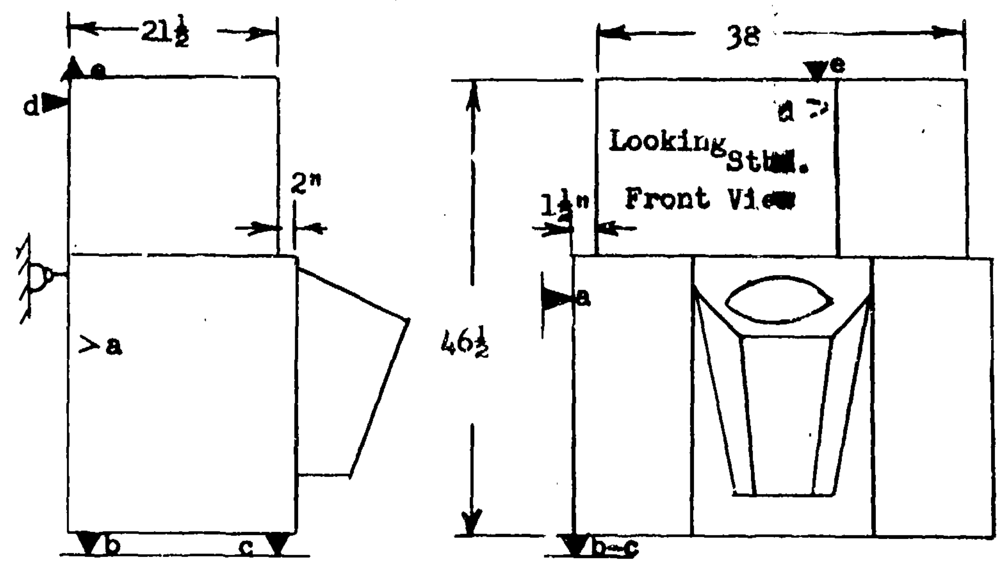
Comments

Able: The shock was greater in the downward than in the upward direction, however it was minor in nature. There was extensive damage just aft of the C.I.C. room, but none apparent in C.I.C.

Baker: A shock of considerable intensity in the vertical direction caused the mounts to bottom. There was no apparent damage.

CA25 #5 Gages:

Location: On Plan Position Indicator (ma[illegible] unit type CG-55ACC) Model SC-2, in C.I.C. Room.



Type of Mounting: Short C type mounts at each bottom corner. L type mounts on upper back corner of main unit. Vertical clearance is about 1/8 inch.

Photograph: BA CR 95-739-2

Vibration Modes:

Rocking Fore and Aft	4.6 cps
Rocking Athwartship	4.5

Deflection (inches):

Gage CA25 #5	a	b	c	d	e
Able	0.26	0.30	0.42	1.60	0.72
Baker	0.19	0.50	0.50	0.75	1.66

Comments

Able: The shock mounts bottomed hard and there was considerable displacement after bottoming due to the bending of the cabinet parts. However, because of the softness of the mounts it is not probable that the shock was severe. There was no apparent damage to the unit.

Baker: The vertical displacements indicate considerable shock in that direction. There was no apparent damage to the unit.

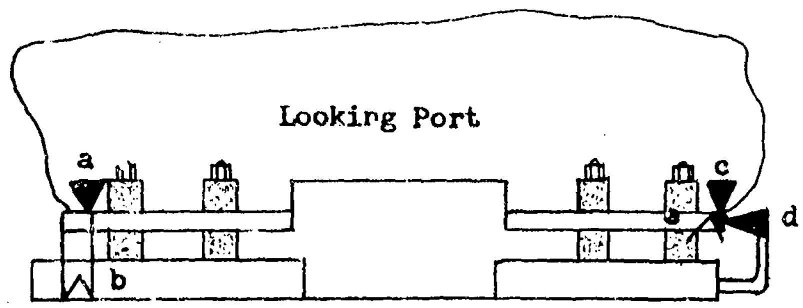
CA25 General Discussion

Able: The spaces just external to all of the compartments considered were exposed to the blast and suffered great structural damage. Inside of the compartments, however, there was little evidence of shock although bottoming of the shock mounted units occurred in many instances. As all antenna systems were swept away it must be concluded that the electronic gear is less vulnerable to shock of these types than associated equipment. Shocks caused by blasts of much greater intensities than these would not occur without destroying the compartment spaces involved. It may be assumed, therefore, that protection for greater intensities of shock than these is not required as far as air blast shock is concerned.

Baker: The ship suffered only minor hull and machinery damage. Nevertheless, the intensity of shock for this test was greater than for test Able. There were several cases of mount failure, and bottoming was quite general.

SS184 #1 Gages:

Location: On Shock Mounted Motor Generator Set, in Port Forward Corner of compartment below the control cubicle



Type of Mounting: Mounts are as shown on each of the four bottom corners of the M-G set. The rubber is about 1 1/4 inches thick.

Photographs: BA CR 140-1601-5 and BA CR 140-1601-6

Deflection (inches):

Gage SS184 #1	a	b	c	d	e
Able	0.00	0.00	0.01	0.00	0.00
Baker	Ship sunk, no data obtained.				

Comments

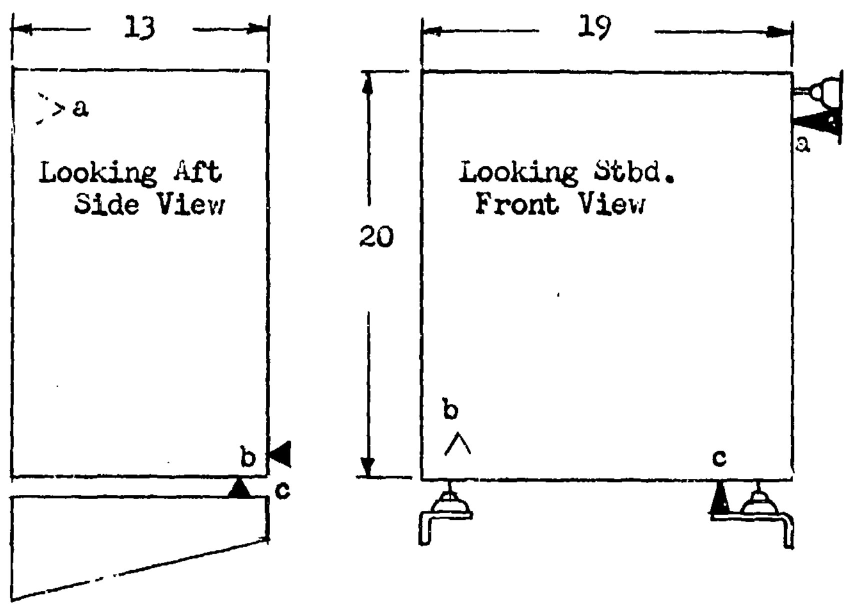
See "General Discussion" for this ship.

SS184 #2 Gages:

Location: On Radar Model SJ-a, type CW-43AAF-1 on Forward Starboard Side of Conning Tower.

Type of Mounting: L type mounts on four bottom corners and on upper back aft corner.

Photograph: BA CR 140-1601-7



<u>Vibration Modes:</u>

Rocking Fore and Aft	11.5 cps
Rocking Athwartship	11.3
Translation Vertical	14

<u>Deflection (inches):</u>

Gages SS184 #2	a	b	c
Able	0.07	0.07	0.09
Baker	-	-	-

<u>Comments:</u>

See "General Discussion" for this ship.

<u>SS184 #3 Gages:</u>

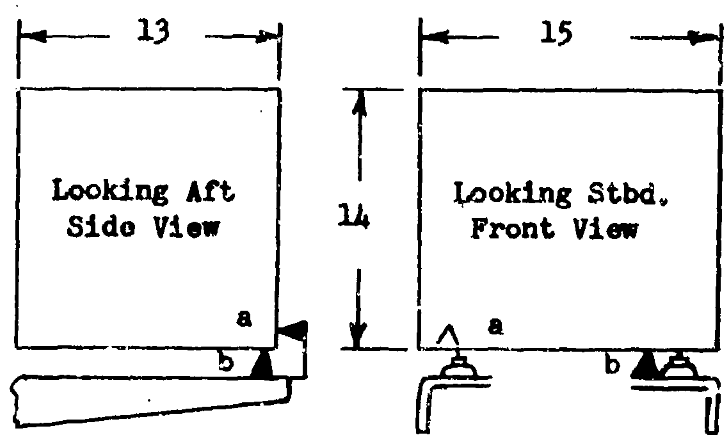
<u>Location:</u> On Radar Model SJ-a, type CZC-23 ADH, on Forward Starboard Side of Conning tower.

<u>Type of Mounting:</u> L type mounts on four bottom corners.

<u>Photograph:</u> BA CR 140-1601-8

<u>Vibration Modes:</u>

Rocking Fore and Aft	15.5 cps
Rocking Athwartship	15.0



Deflection (inches):

Gage SS184 #3	a	b
Able	-- *	0.01
Baker	--	--

*Gage damaged by causes other than shock.

SS184 General Discussion

Able: There was no noticeable shock damage within the Skipjack. The intensity of shock was negligible.

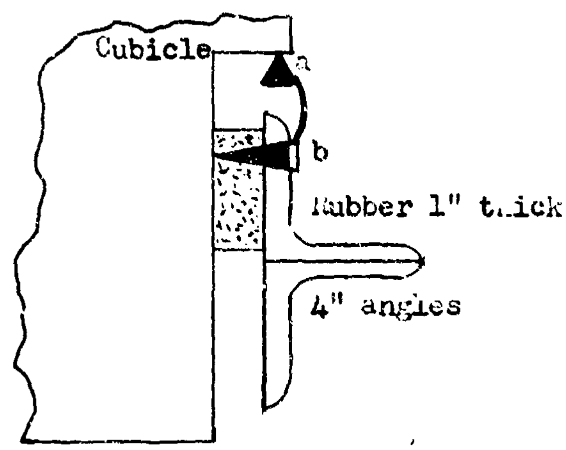
Baker: The ship was sunk by Baker test and no test results are available.

SS196 SEA RAVEN

SS196 #1 Gages

Location: On Control Cubicle, Lower Starboard Edge about four feet from After Edge, in After Maneuvering Room. The gages are shown in the accompanying figure.

Looking Fwd.



Photograph: BA CR 55-814-2

Deflection (inches):

Gage SS196 #1	a	b
Able	0.02	0.00
Baker	0.07	0.02

Comments

See "General Discussion" for this ship.

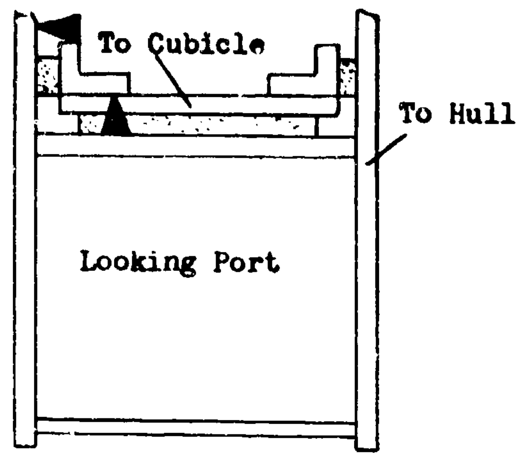
SS196 #2 Gages:

Location: On Control Cubicle, Upper Starboard Mount about 3.5 ft. from After Edge of Cubicle. The gages are shown in the accompanying figure.

Photograph: BA CR 55-814-3

Deflection (inches):

Gage SS196 #2	a	b
Able	0.00	0.02
Baker	0.03	0.02



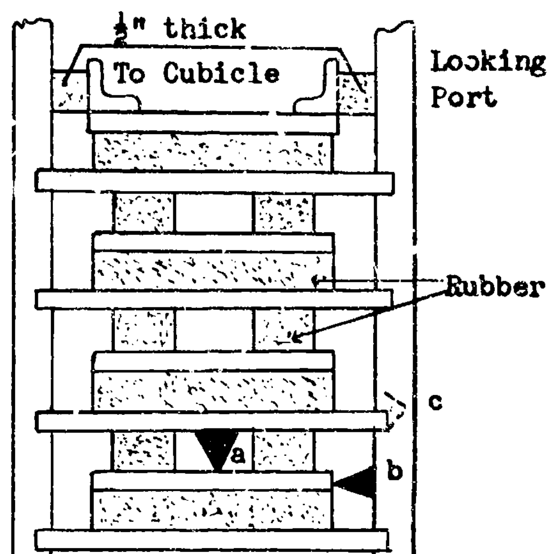
SS196 #3 Gages:

Location: On Control Cubicle, Upper Forward Starboard Corner, in After Maneuvering Room. Gage positions are shown in the figure below.

Mount. Rubber is 1" thick except as noted.

All steel that is rigid to hull is 3/4" thick.

The rest is ½" thick.



Photograph: BA CR 55-814-4

Deflection (inches):

Gages SS196 #3	a	b	c
Able	0.00	0.00	0.03
Baker	0.02	0.03	0.04

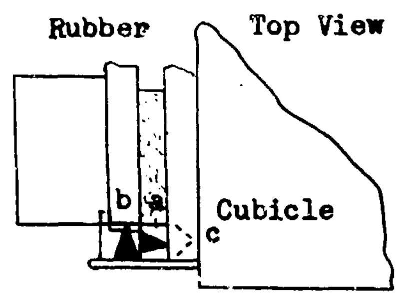
SS196 General Discussion

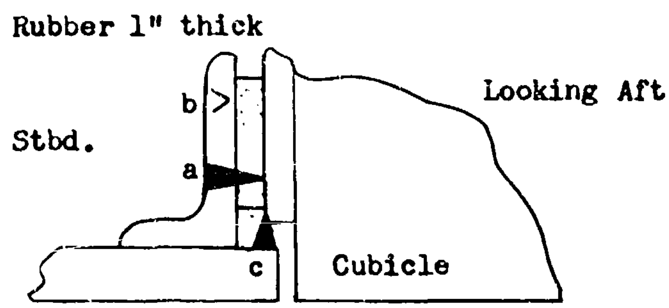
Able and Baker: There was an appreciable evidence of shock or shock damage within the Sea Raven after either the Able or the Baker test.

SS308 APOGAN

SS308 #1 Gages:

Location: On Control Cubicle, Lower Forward Starboard Mount in After Maneuvering Room. Gage positions are illustrated on the accompanying figure.





Photograph: BA CR 55-813-1

Deflection (inches):

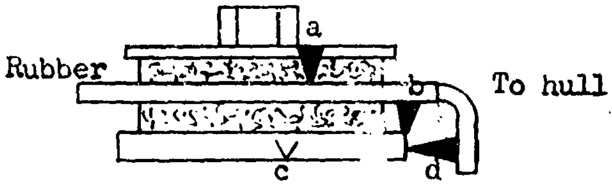
Gage SS308 #1	a	b	c
Able	0.00	0.01	0.00
Baker	--	--	--

Comments

See "General Discussion" for this ship.

SS308 #2 Gages:

Location: On #2 Lighting Motor Generator, Forward Upper Mount, on Port Side of After Maneuvering Room.



Looking Port

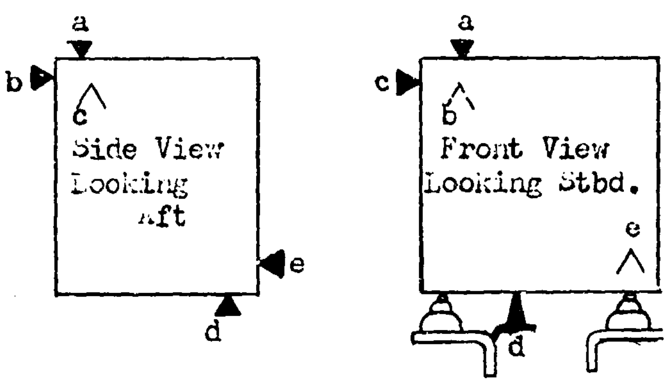
Photograph BA CR 55-813-3

Deflection (inches):

Gages SS 308 #2	a	b	c	d
Able	0.00	0.01	0.01	0.00
Baker	-	-	-	-

SS308 #3 Gages

Location: On Radar Transmitter-Receiver type CR-43ABF-1, in starboard After Corner of Conning Tower.



Type of Mounting: L type mounts on four bottom corners and on two upper back corners. Clearance of mounts about 1/4 inch before bumping on shoulder.

Photograph: BA CR 55-813-8

Vibration Modes:

Rocking Fore and Aft	15 cps
Rocking Athwartship	15
Translation Vertical	15 (may be rocking)

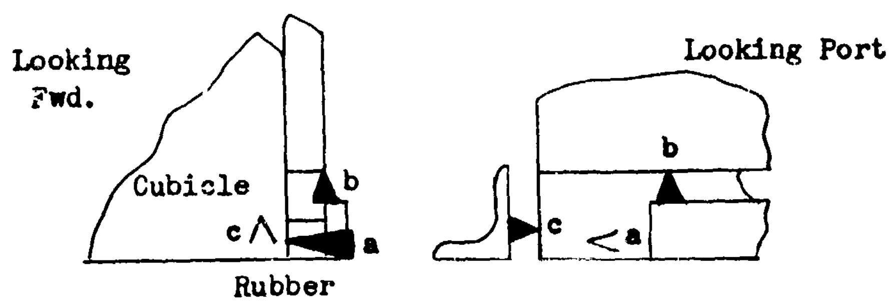
Deflection (inches):

Gages SS308 #3	a	b	c	d	e
Able	0.05	0.05	0.11	0.13	--*
Baker	--	--	--	--	--

*Gage broken.

SS308 #4 Gages:

Location: On Lower After Starboard Corner of Control Cubicle, in After Maneuvering Room.



Photograph: BA CR 55-813-7

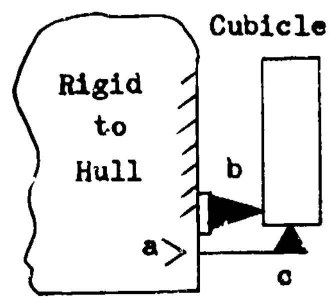
Deflection (inches):

Gage SS308 #4	a	b	c
Able	0.00	---	0.05
Baker	--	---	--

Top Secret

SS308 #5 Gages:

Location: On Upper Forward Port Corner of the Cubicle, in After Maneuvering Room.

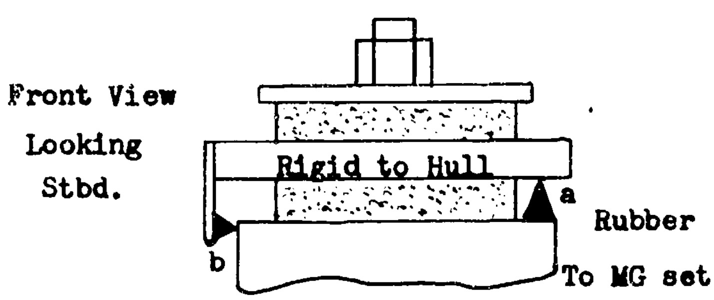


Deflection (inches):

Gage SS308 #5	a	b	c
Able	0.00	0.00	0.01
Baker	--	--	--

SS308 #6 Gages:

Location: On #1 Lighting Motor Generator Set. Upper Forward Mount, on Starboard Side of After Maneuvering Room.



Photograph: BA CR 55-813-5

Deflection (inches):

Gage SS308 #6	a	b
Able	0.00	0.00
Baker	--	--

SS308 General Discussion

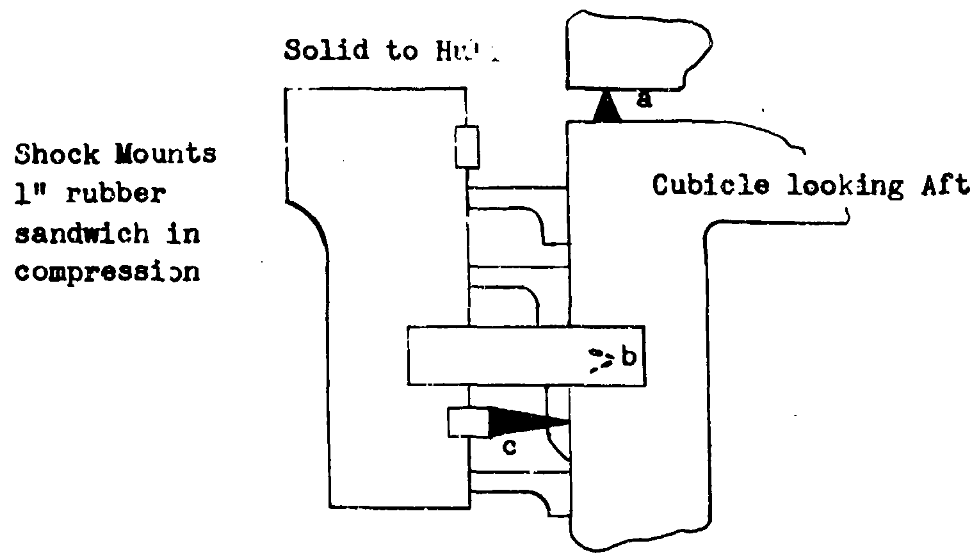
Able: There was no appreciable shock or shock damage within the Apogan during test Able.

Baker: The Apogan was sunk by test Baker and no gage readings were obtained.

SS335 DENTUDA

SS335 #1 Gages:

Location: On Upper Forward Starboard Corner of Control Cubicle in After Maneuvering Room.



Photograph: BA CR 55-813-9

Deflection (inches):

Gage SS335 #1	a	b	c
Able	0.00	0.00	0.02
Baker	0.05	0.05	0.06

Comments

See "General Discussion" for this ship.

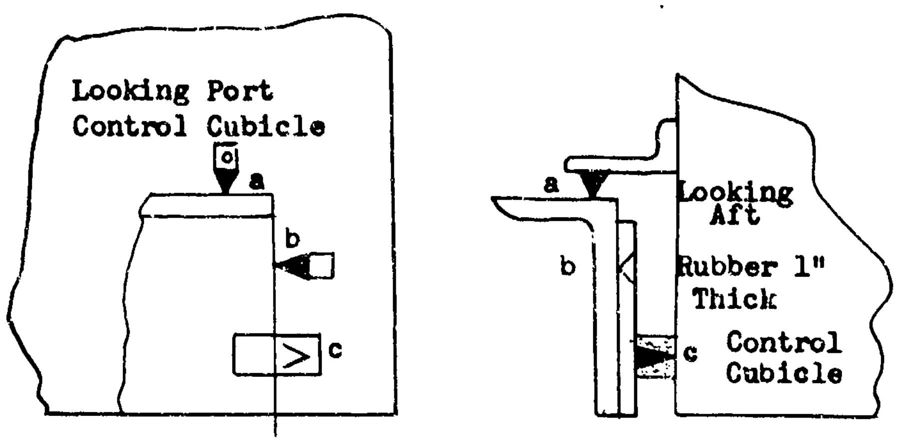
SS335 #2 Gages:

Location: On Lower Forward Starboard Corner of Control Cubicle in After Maneuvering Room.

Photograph: BA CR 55-813-10

Deflection (inches):

Gage SS335 #2	a	b	c
Able	0.00	0.00	0.00
Baker	0.04	0.07	0.05

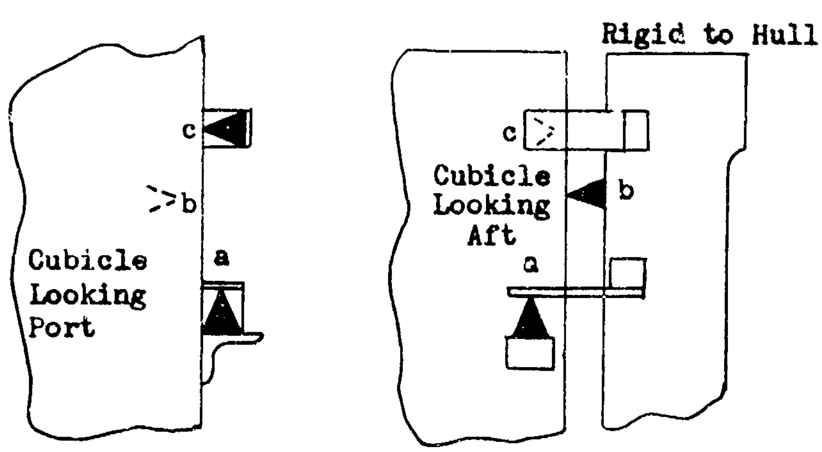


<u>Comments</u>

See "General Discussion" for this ship.

<u>SS335 #3 Gages:</u>

<u>Location</u>: On Upper Forward Port Corner of Control Cubicle in After Maneuvering Room.



<u>Photograph:</u> BA CR 55-813-11

Deflection (inches):

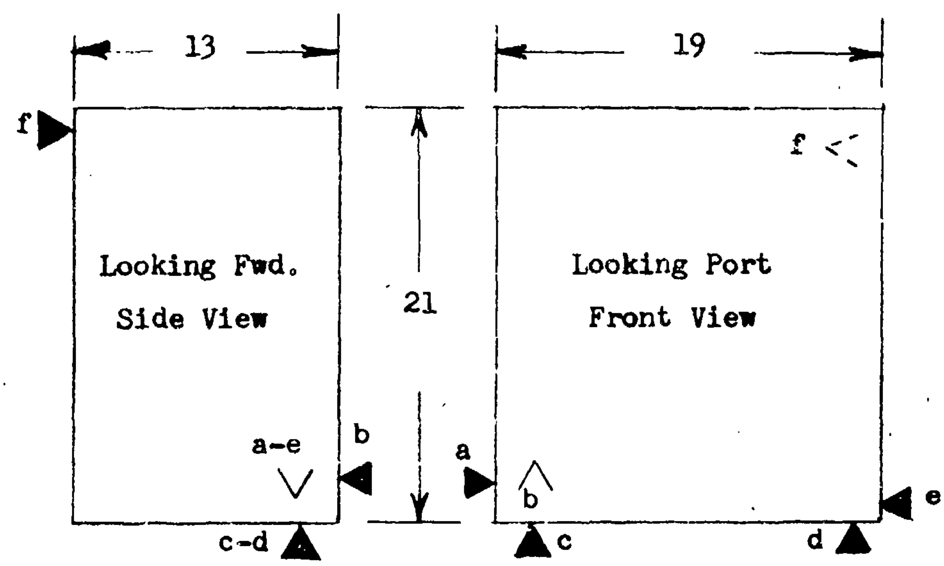
Gages SS335 #3	a	b	c
Able	0.02	0.00	0.00
Baker	0.06	0.05	0.07

Comments

See "General Discussion" for this ship.

SS335 #4 Gages:

Location: On Model SJ-1 Radar Transmitter-Receiver type CW-43AAF-1, at Center of Port Side of Conning Tower.



Type of Mounting: L type mounts on four bottom corners and on two upper back corners. Clearance of mounts is about 1/4 inch to their shoulders which are about 1 inch thick.

Photograph: BA CR 55-813-12

Vibration Modes:

Rocking Fore and Aft	13.1 cps
Rocking Athwartship	15
Translation Vertical	15 (some rocking)

Deflection (inches):

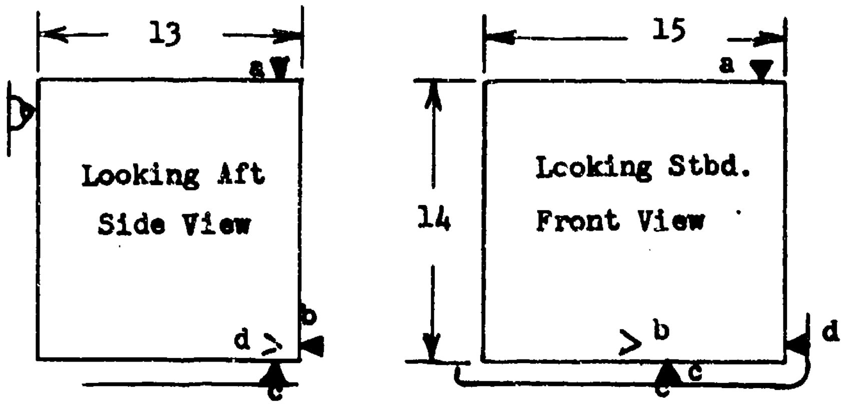
Gage SS335 #4	a	b	c	d	e	f
Able	0.00	0.02	0.01	0.01	0.00	0.02
Baker	0.14	0.29	0.10	0.09	0.10	0.07

Comments

See "General Discussion" for this ship.

SS335 #5 Gages:

Location: On Model SJ-1 Radar Main Control Unit type CBB-23ADH, at Center of Starboard Side of Conning Tower.



Type of Mounting: L type mounts on each of four bottom corners and on the two top back corners. Clearance 1/16 to 1/8 inch to shoulders of mounts.

Photograph: BA CR 55-814-1

Deflection (inches):

Gage SS335 #5	a	b	c	d
Able	0.01	0.00	0.01	0.01
Baker	0.15	--	0.07	0.03

SS335 General Discussion

Able: There was no appreciable shock, or shock damage, within the Dentuda caused by test Able.

Baker: The Dentuda suffered very minor damage from the Baker test. Some small leaks developed that caused it to loose the small amount of buoyancy that it had, but if personnel had been aboard no trouble would have occurred. From displacements recorded on similar gear on the SS263 Dragonet, which was subjected to a controlled depth charge test (NRL Report 0-2362) it is estimated that the

Baker test was about equivalent to a 300 lb. depth charge distant about 100 to 150 ft. abeam of the submarine. The deflections of the apparatus were of small magnitude and little shock damage occurred.

GENERAL CONCLUSIONS

Able Test

Surface Ships

The following generalizations can be made from general observations and from the lead gage data concerning Able blast and its effects on shock mounted equipment in surface ships.

1. There was no appreciable shock intensity below the main deck.
2. There was little shock damage to equipment that was contained within closed compartments above the main deck, as long as: (a) the compartment was not torn open so as to expose the equipment to the direct blase, (b) the equipment was mounted only to the deck and, (c) there was sufficient clearance (about 6" from central parts of exterior bulkheads) to prevent collisions.
3. Stabilizing mounts, that connected the top of an equipment to a bulkhead, very frequently failed. It is suggested that such stabilizing mounts include suitable shaped strap iron components that will deflect plastically at stresses several times that normally encountered and with clearances of several inches. Under no circumstances should any vulnerable equipment be mounted to exterior bulkheads.
4. It can be concluded that for equipment mounted to decks or protected interior bulkheads a minimum clearance of 1/2 inch would be sufficient to adequately protect equipment from severe bottoming because of translational motions, if the translational frequencies of the mounted equipment are greater than 10 cps. However, displacements involved in rocking modes were several inches in amplitude and a redesign and relocation of the mounting systems should be done to adequately protect the equipment. If sufficient clearances were provided, the displacements would not be objectionable for the brief period of the shock. Bottoming of shock mounted equipment occurred up to 1500 yards from the bomb, but little serious damage to this equipment occurred beyond 1000 yards. Plates 3 and 4 show typical displacements of two kinds of equipment. The mounting arrangements for all units of a given type were very similar. The

flexibility and lack of strength of exterior bulkheads caused them to deform and to be destroyed before more than moderate shock intensities were transmitted to interior deck surfaces. Because of the greater structural strength and rigidity of the heavier ships a moderate damage of their external members caused a more severe shock within the compartments that they enclosed than did corresponding structural damage aboard a destroyer.

Able Test

Submarines

The nearest submarine to the Able blast that was instrumented with lead gages was about 1000 yards. There was no appreciable shock damage or intensity of shock within surfaced submarines at this distance. The shock would be expected to be less for submerged vessels. Deflections of shock mounted equipments were generally less than 0.1 inch. It should be noted that the shock mounted equipment aboard submarines was more rigidly mounted and the mounts were better located (reduced coupling between the rocking and translation modes of vibration) than was the equipment aboard other ships.

Baker Test

In destroyers the shock mounted equipment, that was instrumented with lead gages, was located on the superstructure decks. In the cruisers the instrumented equipment was also on the superstructure decks although the C.I.C. room was an interior compartment just above the main deck. The battleship had instrumented shock mounted equipment both on the 3rd deck and on the signal and flag decks. As the underwater shock is transmitted to the ship via the underwater hull it is to be expected that the shock would have attenuated to relatively small intensity at these locations. Nevertheless the displacements of shock mounted apparatus was nearly as great in the Baker test as for Able for equipment in destroyer superstructures and for ship at equal distances from the bombs. In the cruisers the shock within superstructure compartments was of greater intensity for the Baker test than for the Able for ships at equal distances from the bombs. In the battleship the shock, as evidenced by the deflections of shock mounted apparatus, was as great in the superstructure as on the 3rd deck near the ships centerline. It is apparent that the rigidity of battleships and cruisers is sufficient to transmit a considerable intensity of low frequency shock components from the hull to remote parts of the ship. It can be concluded however, that shock mounted electronic equipment,

located distant from the hull of a ship, can withstand shocks caused by underwater explsions, better than machinery items located near the hull. If it is conceded that electronic equipment is to be located at considerable distances from the hull, as was the case for all equipment considered in this report, then the present Navy "High Impact" shock specifications can be relaxed by a limited amount. This does not apply to equipment mounted within submarines about which nothing can be said as no submarine that suffered only moderate damage was instrumented with lead gages.

Plates 5 and 6 show the relative displacements of two types of equipment, each type of which was mounted in a similar manner on many different ships. These are comparable with similar charts for the Able test. It can be approximately stated while considerable bottoming of shock mounted equipment occurs for ships up to about 1500 yards from the bomb for both Able and Baker tests, there was little extensive damage to the mounts or their supported equipments at distances greater than 1000 yards. At distances of about 900 yards or less, for Baker test, the shock mounts and their supported equipment are subject to considerable damage at all locations on a ship.

<u>Miscellaneous Shock Intensity Notes</u>

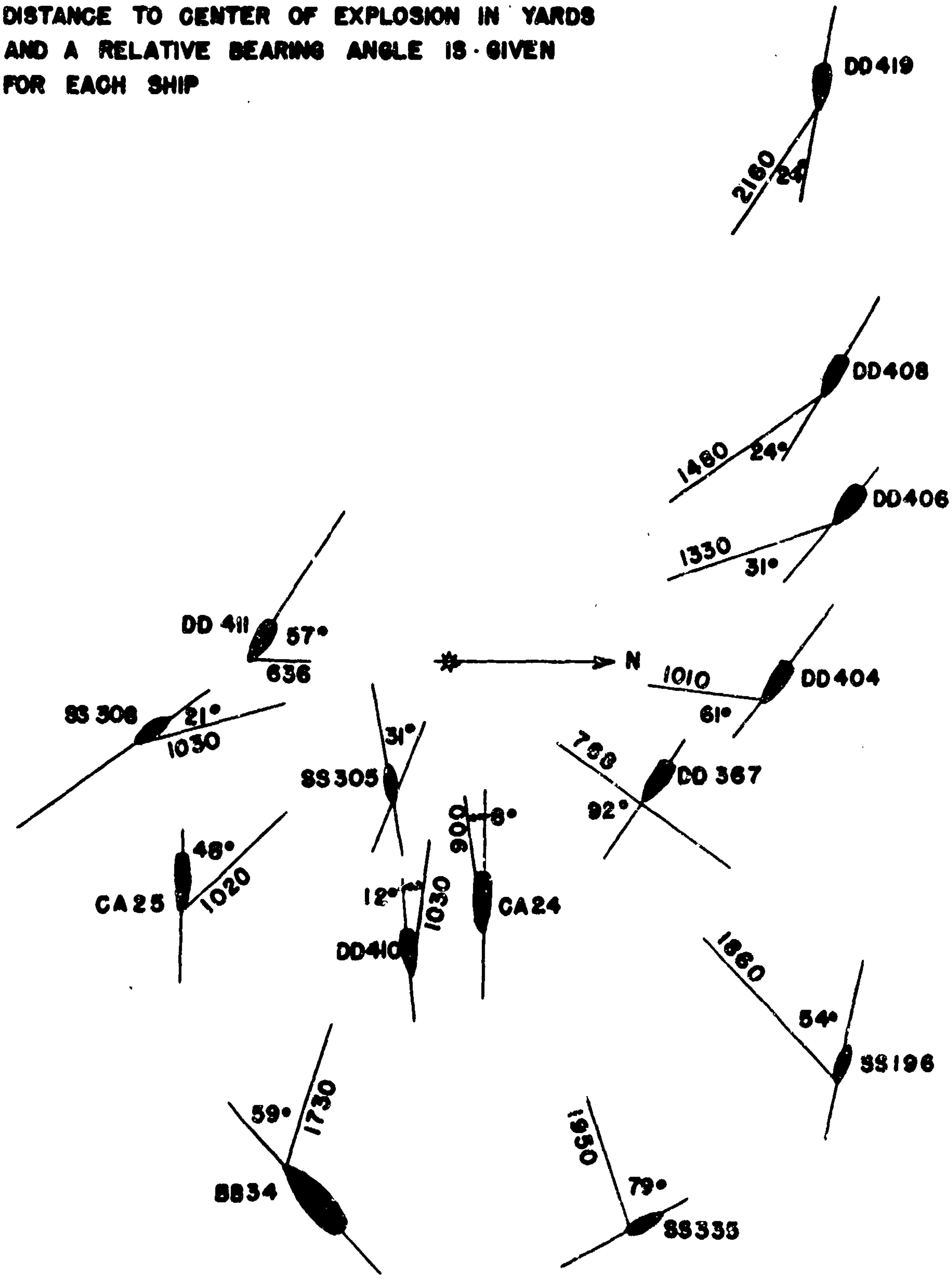
Several factors should be emphasized concerning the general maximum intensity of shock which ship's equipment must be required to withstand. It is generally agreed that for non-contact underwater explosions, equipment on board ship should be constructed and mounted so as to remain operable as long as the hull structure prevents uncontrollable flooding. It is apparent from the Bikini test that equipment protected from the direct Able blast, and built to withstand the maximum shock from underwater explosions, can easily withstand the shock caused by the Able test. Exceptions would be made for equipment mounted on, or very near to, exposed external decks and bulkheads because of the large displacements involved.

For Baker test only one ship considered in this report suffered a shock which would border on uncontrollable flooding. This was the DD410, located about 630 yard from the explosion which was off the starboard beam. From a superficial observation of the shock damage there was no doubt that equipment built to pass present shock specifications would have difficulty surviving a shock of this severity.

The Pensacola (CA24) was about 770 yards from the Baker explosion as measured from near midship. The explosion was off the bow of the ship. While some flooding occurred, the damage to the hull was far from the limit of uncontrollable flooding. An intensity of shock, as would be caused by the explosion off the beam of the ship and at a distance of about 600 yards, would be expected to be of a limiting value. These figures are taken, as they are close to the orientation of the Hughes (DD410). Other ships, as the New York and the Salt Lake City, suffered relatively minor shocks compared with the limiting value set by uncontrollable flooding.

TARGET ARRAY OF SHIPS INSTRUMENTED WITH "X" GAGES
TEST ABLE

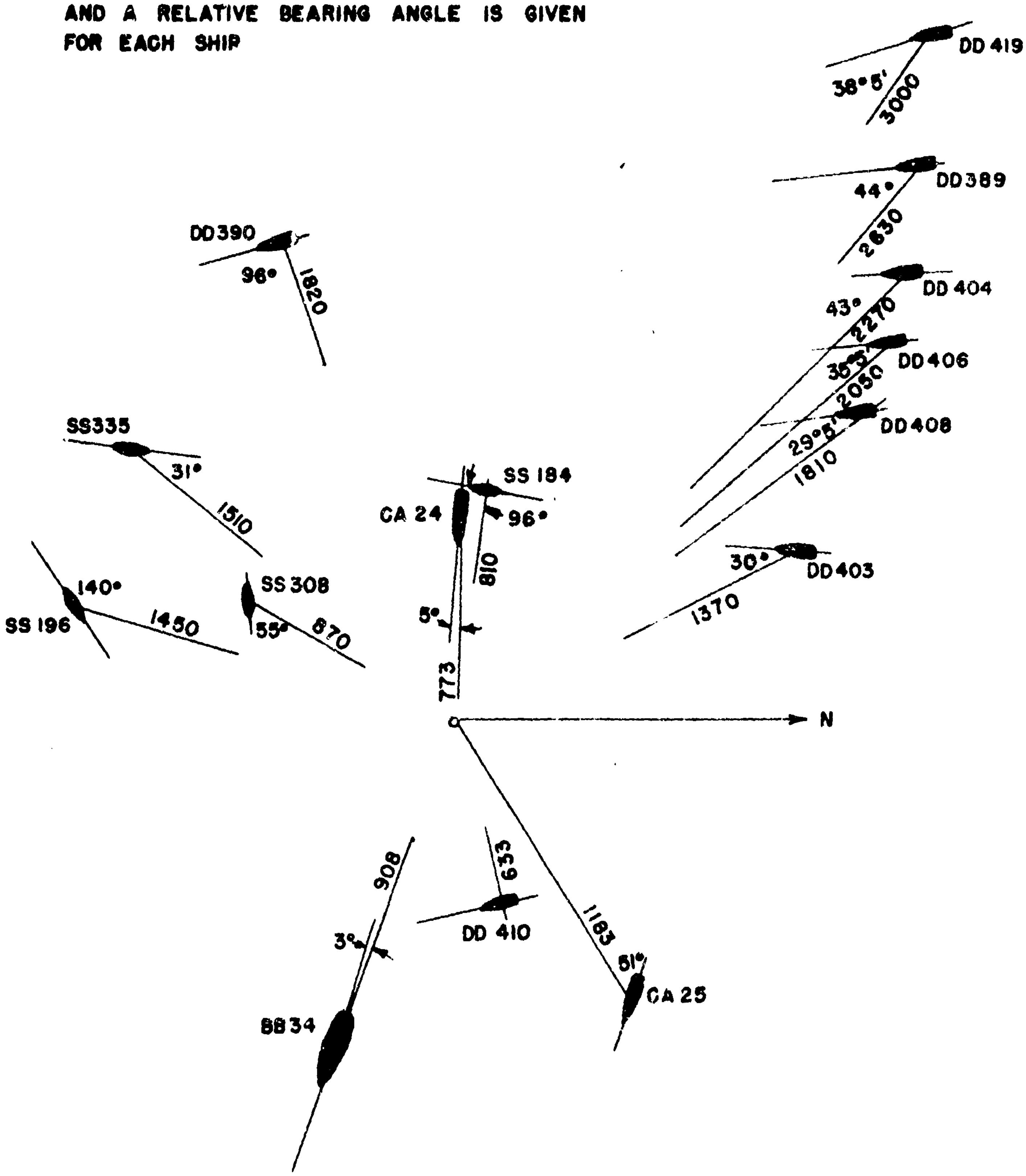
DISTANCE TO CENTER OF EXPLOSION IN YARDS
AND A RELATIVE BEARING ANGLE IS GIVEN
FOR EACH SHIP



TOP
SECRET

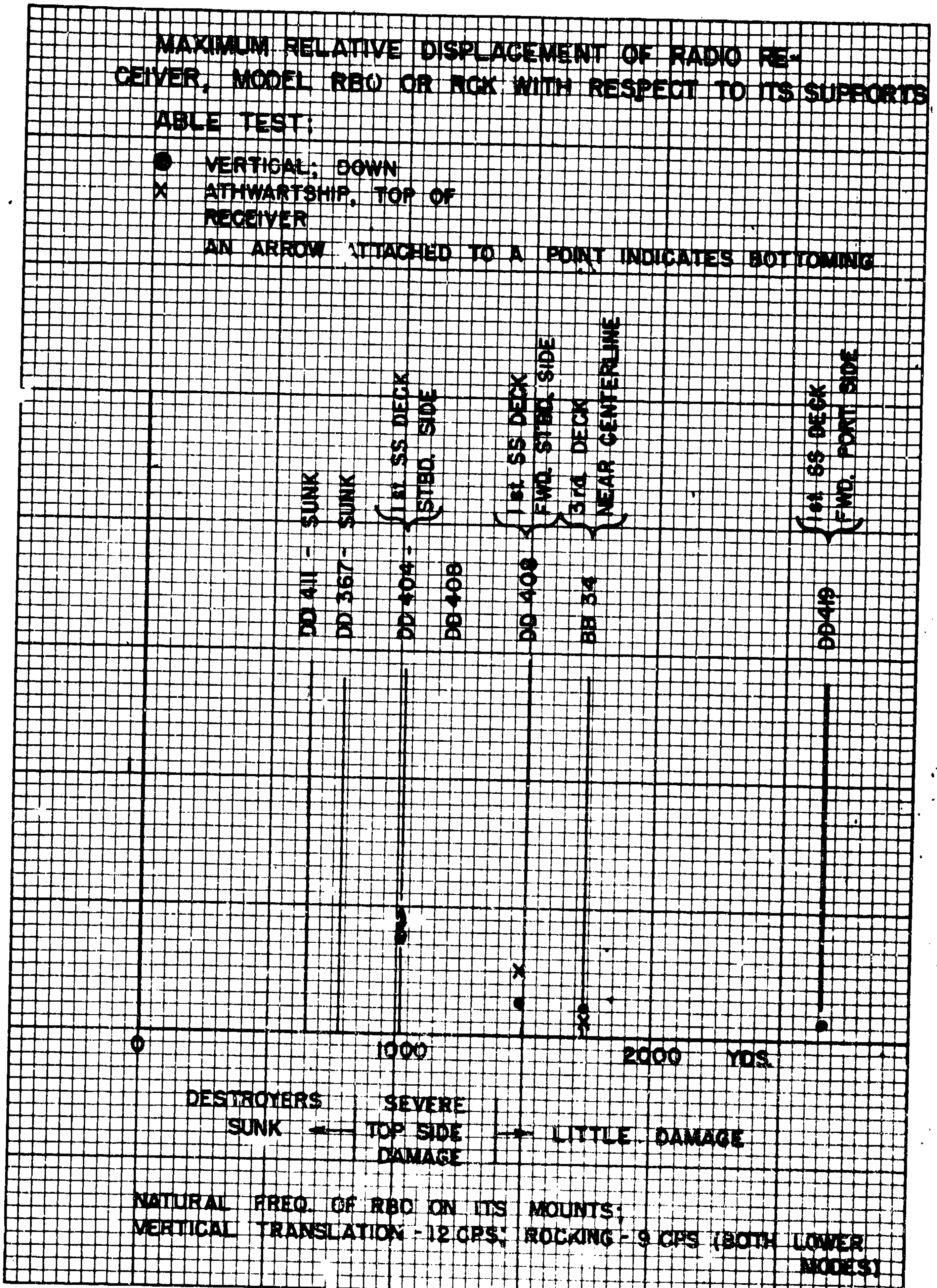
TARGET ARRAY OF SHIPS INSTRUMENTED WITH "X" GAGES
TEST BAKER

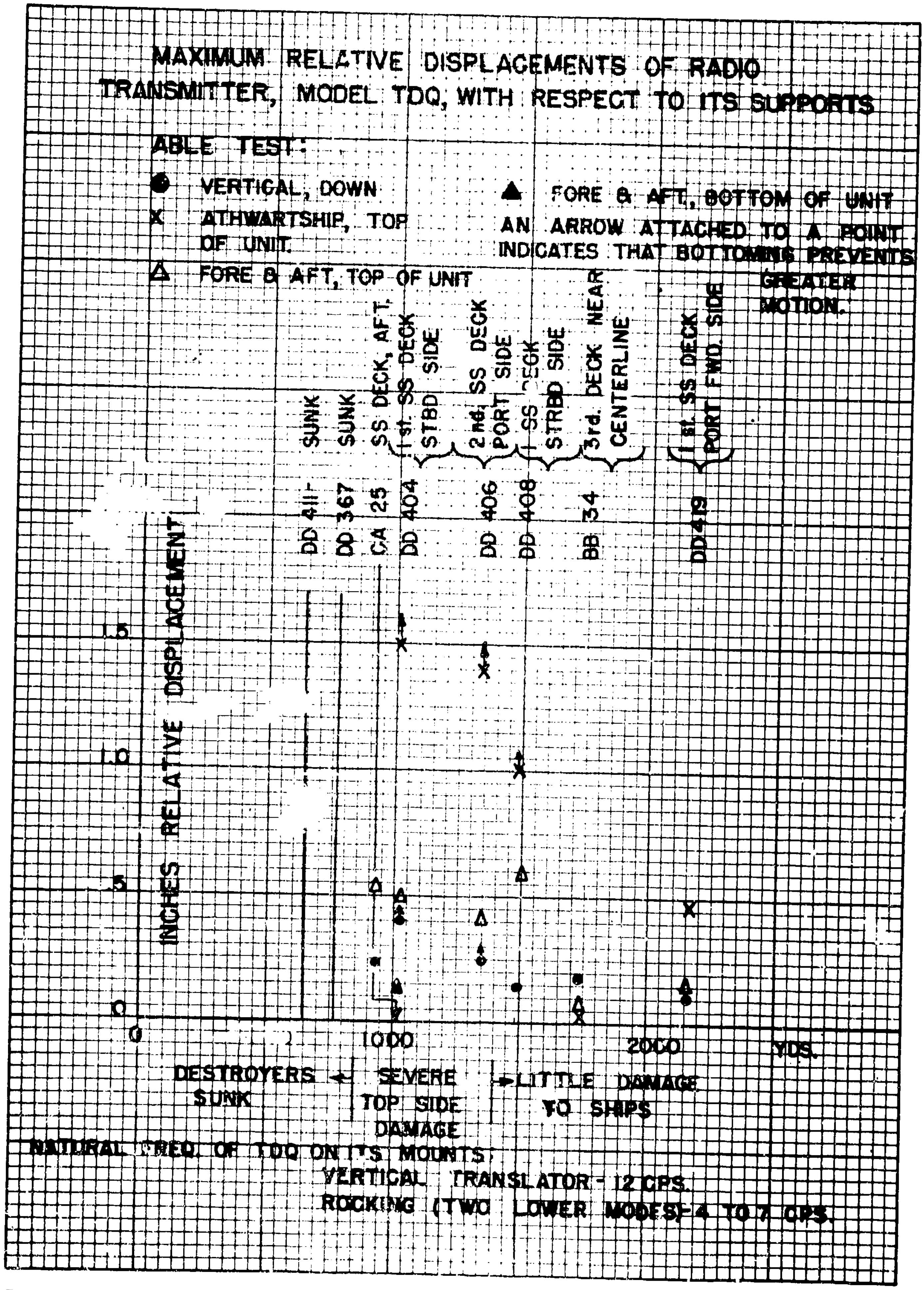
DISTANCE TO CENTER OF EXPLOSION IN YARDS AND A RELATIVE BEARING ANGLE IS GIVEN FOR EACH SHIP

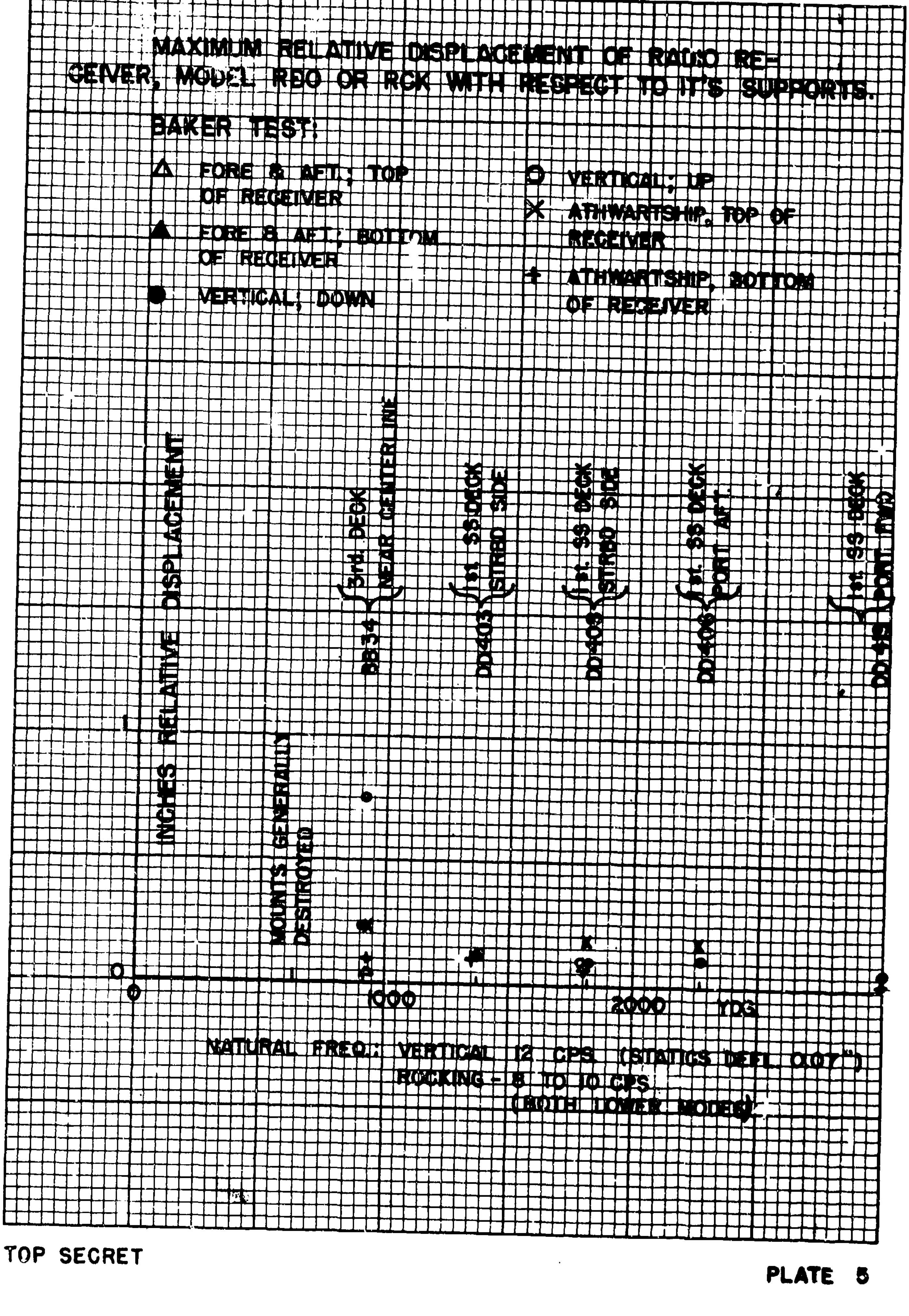


TOP SECRET

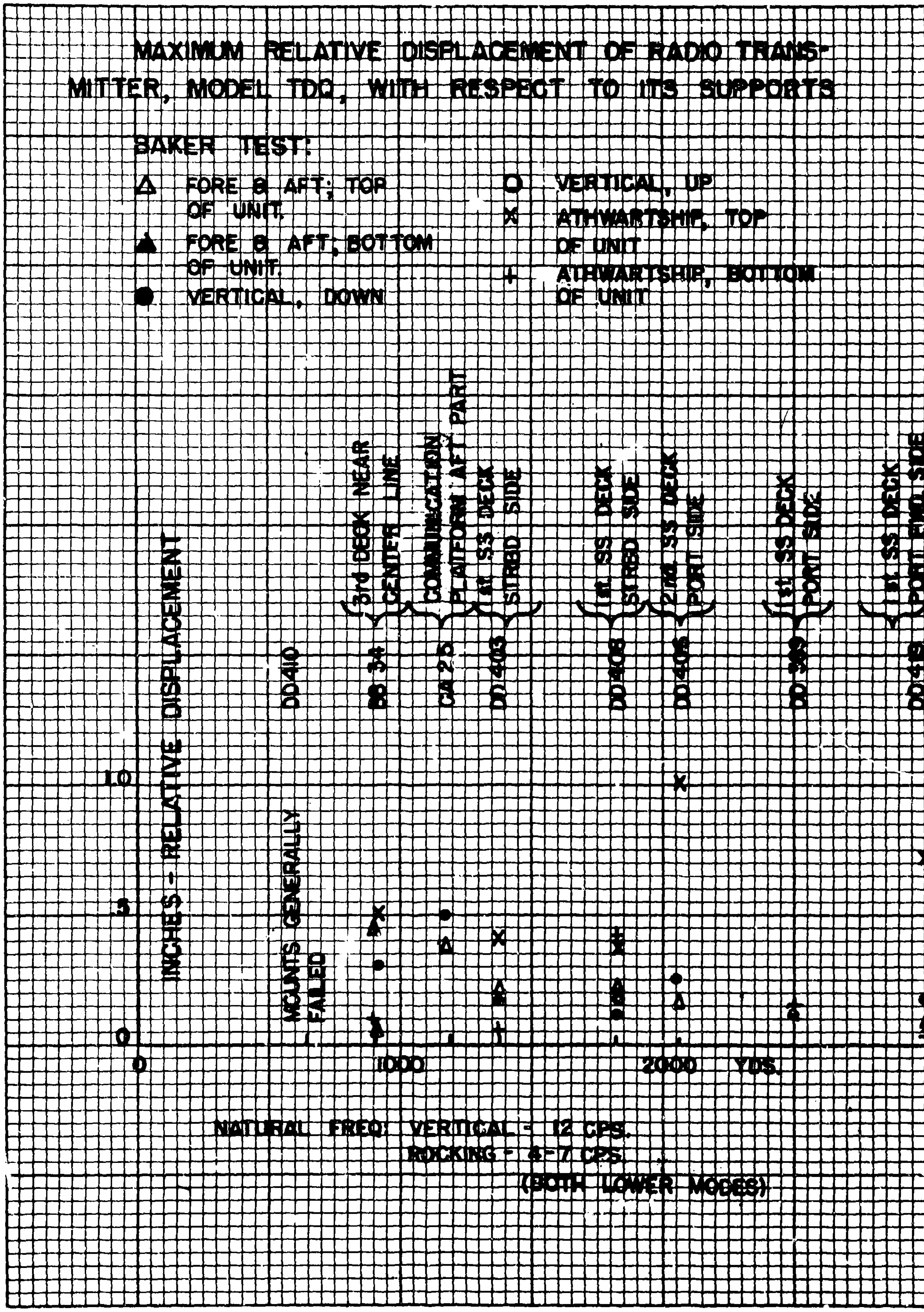
PLATE 2

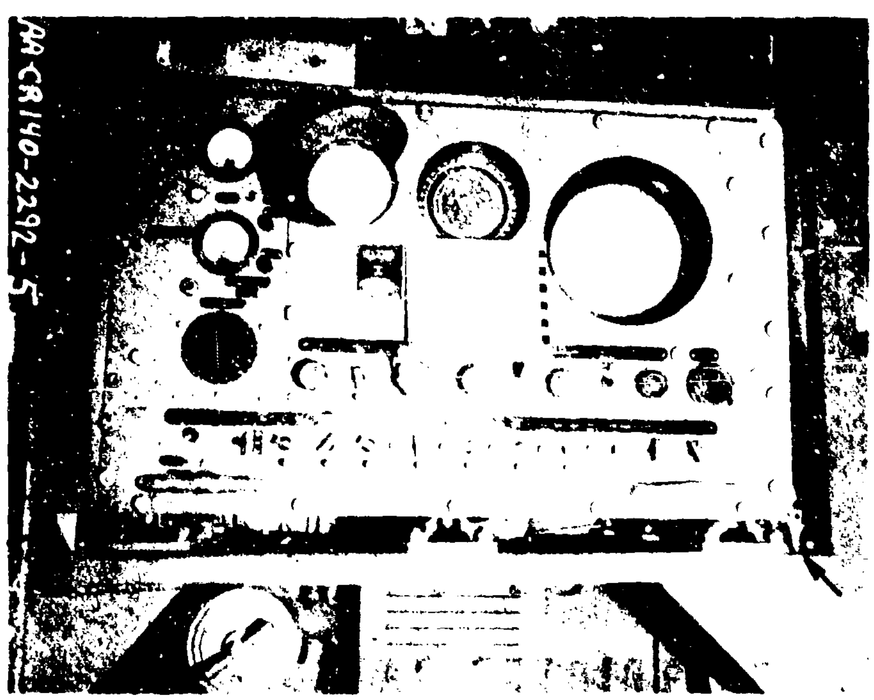

MAXIMUM RELATIVE DISPLACEMENT OF RADIO RE-
CEIVER, MODEL RBO OR RCK WITH RESPECT TO ITS SUPPORTS
ABLE TEST:
● VERTICAL; DOWN
X ATHWARTSHIP, TOP OF RECEIVER
AN ARROW ATTACHED TO A POINT INDICATES BOTTOMING
DD 411 - SUNK
DD 367 - SUNK
DD 404 - 1st. SS DECK STBD. SIDE
DD 408
DD 408 1st. SS DECK FWD. STBD. SIDE
BB 34 3rd. DECK NEAR CENTERLINE
DD 419 1st. SS DECK FWD. PORT SIDE
0
1000
2000
YDS.
DESTROYERS SUNK
SEVERE TOP SIDE DAMAGE
LITTLE DAMAGE
NATURAL FREQ. OF RBO ON ITS MOUNTS;
VERTICAL TRANSLATION - 12 CPS; ROCKING - 9 CPS (BOTH LOWER MODES)


MAXIMUM RELATIVE DISPLACEMENTS OF RADIO TRANSMITTER, MODEL TDQ, WITH RESPECT TO ITS SUPPORTS
ABLE TEST:
VERTICAL, DOWN
X ATHWARTSHIP, TOP OF UNIT
FORE & AFT, TOP OF UNIT
FORE & AFT, BOTTOM OF UNIT
AN ARROW ATTACHED TO A POINT INDICATES THAT BOTTOMING PREVENTS GREATER MOTION.
DD 411 - SUNK
DD 367 SUNK
CA 25 SS DECK, AFT.
DD 404 1st. SS DECK STBD SIDE
DD 406 2nd. SS DECK PORT SIDE
DD 408 1 SS DECK STRBD SIDE
BB 34 3rd. DECK NEAR CENTERLINE
DD 419 1 st. SS DECK PORT FWD. SIDE
INCHES RELATIVE DISPLACEMENT
1.5
1.0
.5
0
0
1000
2000
YDS.
DESTROYERS SUNK
SEVERE TOP SIDE DAMAGE
LITTLE DAMAGE TO SHIPS
NATURAL FREQ. OF TDQ ON ITS MOUNTS:
VERTICAL TRANSLATOR - 12 CPS.
ROCKING (TWO LOWER MODES) - 4 TO 7 CPS.


MAXIMUM RELATIVE DISPLACEMENT OF RADIO RECEIVER, MODEL RBO OR RCK WITH RESPECT TO IT'S SUPPORTS.
BAKER TEST:
FORE & AFT.; TOP OF RECEIVER
FORE & AFT.; BOTTOM OF RECEIVER
VERTICAL; DOWN
VERTICAL; UP
ATHWARTSHIP, TOP OF RECEIVER
ATHWARTSHIP, BOTTOM OF RECEIVER
INCHES RELATIVE DISPLACEMENT
1
0
MOUNTS GENERALLY DESTROYED
BB 34 3rd. DECK NEAR CENTERLINE
DD 403 1st. SS DECK STRBD SIDE
DD 409 1st. SS DECK STRBD SIDE
DD 406 1st. SS DECK PORT AFT.
DD 1st. SS DECK PORT FWD
0
1000
2000
YDS.
NATURAL FREQ.: VERTICAL 12 CPS (STATICS DEFL. 0.07")
ROCKING - 8 TO 10 CPS
(BOTH LOWER MODES)

TOP SECRET


MAXIMUM RELATIVE DISPLACEMENT OF RADIO TRANSMITTER, MODEL TDQ, WITH RESPECT TO ITS SUPPORTS
BAKER TEST:
FORE & AFT; TOP OF UNIT.
FORE & AFT; BOTTOM OF UNIT.
VERTICAL, DOWN
VERTICAL, UP
ATHWARTSHIP, TOP OF UNIT
ATHWARTSHIP, BOTTOM OF UNIT
INCHES - RELATIVE DISPLACEMENT
MOUNTS GENERALLY FAILED
DD 410
BB 34
3rd DECK NEAR CENTER LINE
CA 25
COMMUNICATION PLATFORM AFT PART
DD 403
1st SS DECK STRBD SIDE
DD 408
1st SS DECK STRBD SIDE
DD 406
2nd SS DECK PORT SIDE
DD 399
1st SS DECK PORT SIDE
DD 413
1st SS DECK PORT FWD SIDE
1.0
.5
0
0
1000
2000
YDS.
NATURAL FREQ: VERTICAL - 12 CPS.
ROCKING - 4-7 CPS.
(BOTH LOWER MODES)



TYPICAL INSTALLATIONS OF "X" AS LEAD GAGES
(ARROWS POINT TO GAGES)

PLATE 7

CONFIDENTIAL

(6) OPERATION CROSSROADS,

Report of

BUREAU OF SHIPS INSTRUMENTATION GROUP,

SECTION X,

SHOCK MEASUREMENTS [U], (8)

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Director
Defense Atomic Support Agency

(11) 1947, (12) 1v,

10 R. E. Blake, J. P. Walsh I. Vigness.

(14) XRD-201

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RESTRICTED DATA
ATOMIC ENERGY ACT 1954

CONFIDENTIAL

Report On

SHOCK MEASUREMENTS

The measurements reported on herein were made by Messrs J.P. Walsh, R.E. Blake, W.M. Mitchell, and Lt. P.T. Egbert, USNR, all of the Naval Research Laboratory. The report was prepared by Mr. R.E. Blake, with the guidance and assistance of Mr. J.P. Walsh and Dr. I. Vigness.

TABLE OF CONTENTS

SECTION I

INTRODUCTION

This report is concerned with the shock motion produced aboard the target ships by the Able and Baker test explosions. Measurements of shock motion are of prime interest in order to determine the motions and forces to which shipboard equipment is subjected.

Approximately 315 shock measurement gages were installed on nine ~~(9)~~ destroyers, eight ~~(8)~~ submarines, two ~~(2)~~ cruisers, three ~~(3)~~ battleships, and three ~~(3)~~ attack transports. Each gage was placed at an actual or potential location of shipboard equipment (turbine, switchboard, electronic gear, radar antenna, etc.) with the purpose of measuring some characteristic of the shock motion (i.e. peak acceleration, velocity-time curve, frequency-response spectrum, etc.). The following types of gages were used:

Gage	Number Used	Symbol
Putty Gage	176	G
Multi-Frequency Reed Gage	47	R'
Motorized Reed Gage	18	R''
Velocity Meter	20	V'
Indenter Gage	46	Q
Shock Displacement Gage	8	O

The material in this report is arranged according to the following outline:

Section II is a discussion of the theory, description, and accuracy of the various gages.

Section III is a discussion of the overall plan or philosophy of the gage locations.

Section IV is a detailed ship-by-ship description of individual gage locations and presentation of the data for each gage. The group of data for each ship is followed by a discussion of that data.

Section V is a discussion of all the data and a comparison of the data from different ships.

Section VI presents the conclusions drawn from the tests.

SECTION II

GAGE CHARACTERISTICS *

Putty Gage.

The putty gage is a mechanical instrument designed to measure the maximum value of the acceleration to which it is subjected. The diagramatic sketch, Figure 1, shows the major features of this gage. In the sketch, Part 1 is a weight which is pressed against the top of the gage frame, 3, by the precompression of the spring, 2. An extension of the weight has a conical point which is about .001 inch from the surface of the plasticine (putty) insert 4.

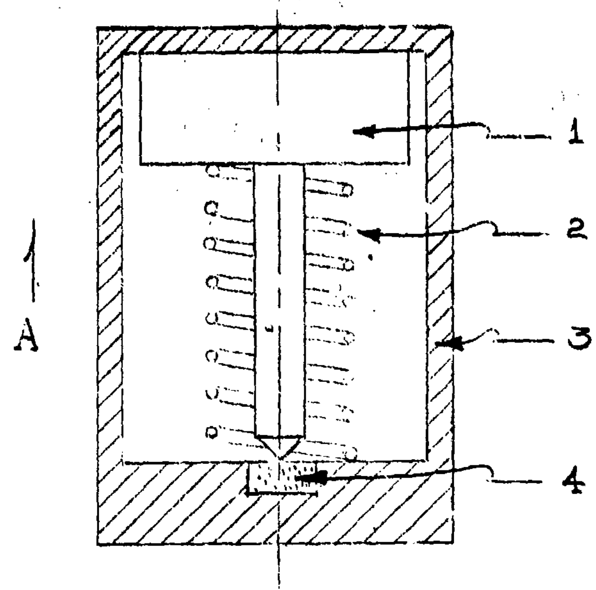


Figure 1 - Single Element of Putty Gage.

When the frame is accelerated in the direction indicated by the arrow, the acceleration and motion of the weight will be identical to that of the frame as long as the force exerted by the spring exceeds the inertia force of the weight against the spring. At some critical acceleration, the weight can no longer be held against the frame and it will then indent the putty. For gradually applied acceleration, the critical acceleration, A_c, is given by the equation $A_c = \frac{F_s}{M_w + \frac{1}{2} M_s}$ where M_w and M_s are the mass of the weight and spring, respectively, and F_s is the precompression force of the spring.

* The theory of some of these gages is taken in part from Reference 1. An addition to Reference 1 will contain the discussion of this section in more complete form. The References are listed at the end of Section III.

The plasticine inserts were in a plastic disk so keyed to the frame that the inserts could be identified after removal of the disk from the instrument. The gages were read by measurement with a travelling microscope of the diameter of the indentations which had been made in the inserts. The maximum acceleration of the gage is assumed to lie between the larget critical acceleration of those elements which made indentations and the lowest critical acceleration of those elements which did not make indentations. The accelerations reported are interpolations between these two values based upon the size of the indentations made.

Each putty gage used in the tests had eight elements with critical acceleration values ranging from 20 to 2500 g. (g is the acceleration of gravity.) In order to concentrate the critical acelerations of a gage in the neighborhood of the expected reading, two ranges of critical acceleration were standardized upon. These accelerations are tabulated in Column 1 of Tables 1 and II.

TABLE I

Low Range Putty Gages

Element No.	1 A_c (g)	2 T (Milliseconds)	3 F_s c.p.s.	4 M_s/M_w	5 A_c/A for $T_o/T=1$	6 A_c/A for $T_o/T=1$
1	20	1.38	362	.070	.66	.88
2	50	1.38	362	.070	.77	.95
3	90	1.02	490	.214	.77	.95
4	150	1.02	490	.214	.85	.97
5	300	0.52	970	.519	.74	.94
6	700	0.52	970	1.58	.88	.98
7	1200	0.52	970	1.58	.92	.98
8	1800	0.52	970	1.58	.96	.99

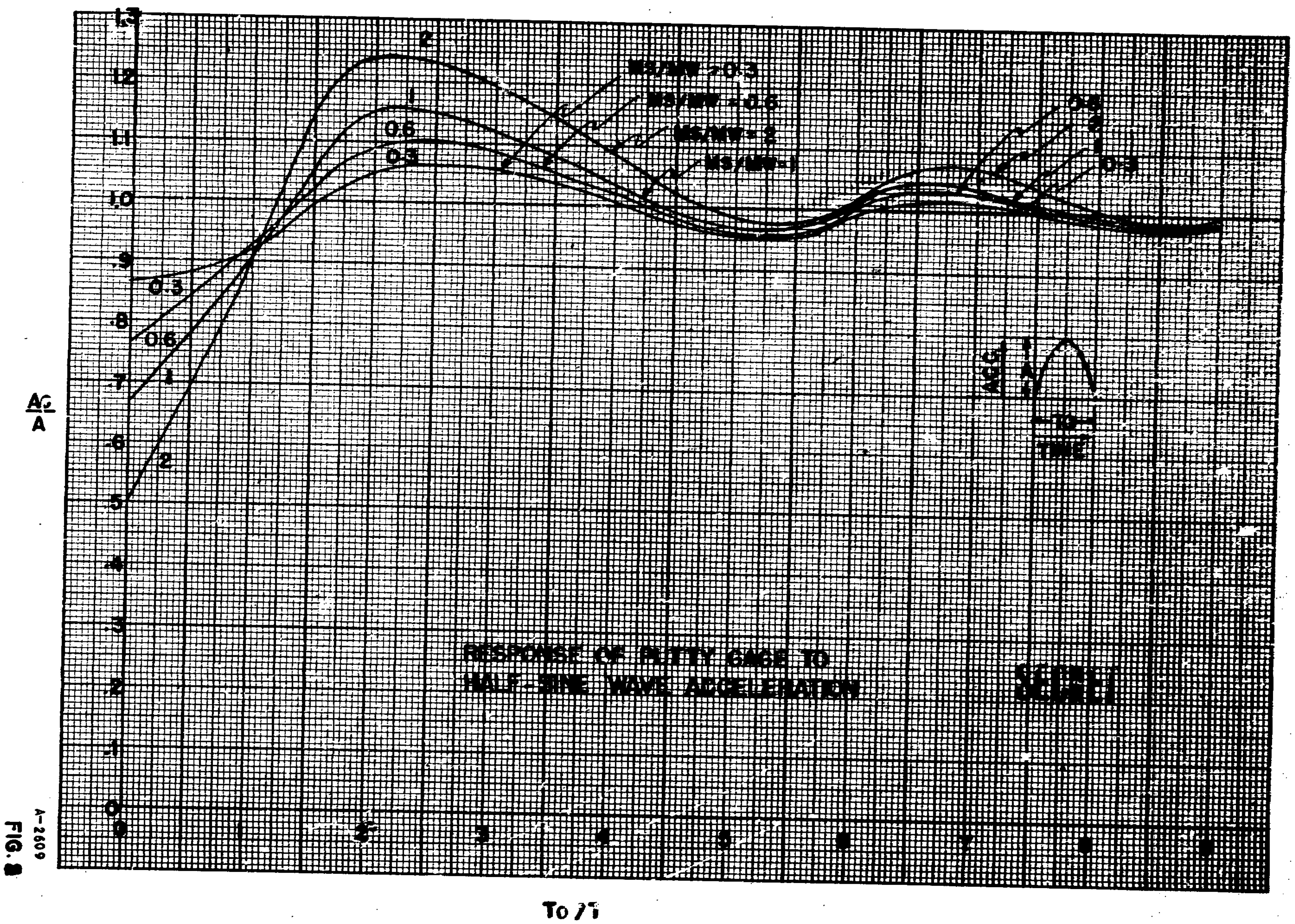
TABLE II

High Range Putty Gages

Element No.	1 A_c (g)	2 T (Milliseconds)	3 F_s c.p.s.	4 M_s/M_w	5 A_c/A for $T_o/T=1$	6 A_c/A for $T_o/T=1$
1	50	1.38	362	.070	.77	.95
2	100	1.02	490	.214	.79	.95
3	300	.52	970	.519	.74	.94
4	650	.52	970	.519	.87	.98
5	1000	.52	970	.519	.91	.98
6	1500	.52	970	1.58	.94	.985
7	2000	.52	970	1.58	.97	.99
8	2500	.52	970	1.58	.98	.995

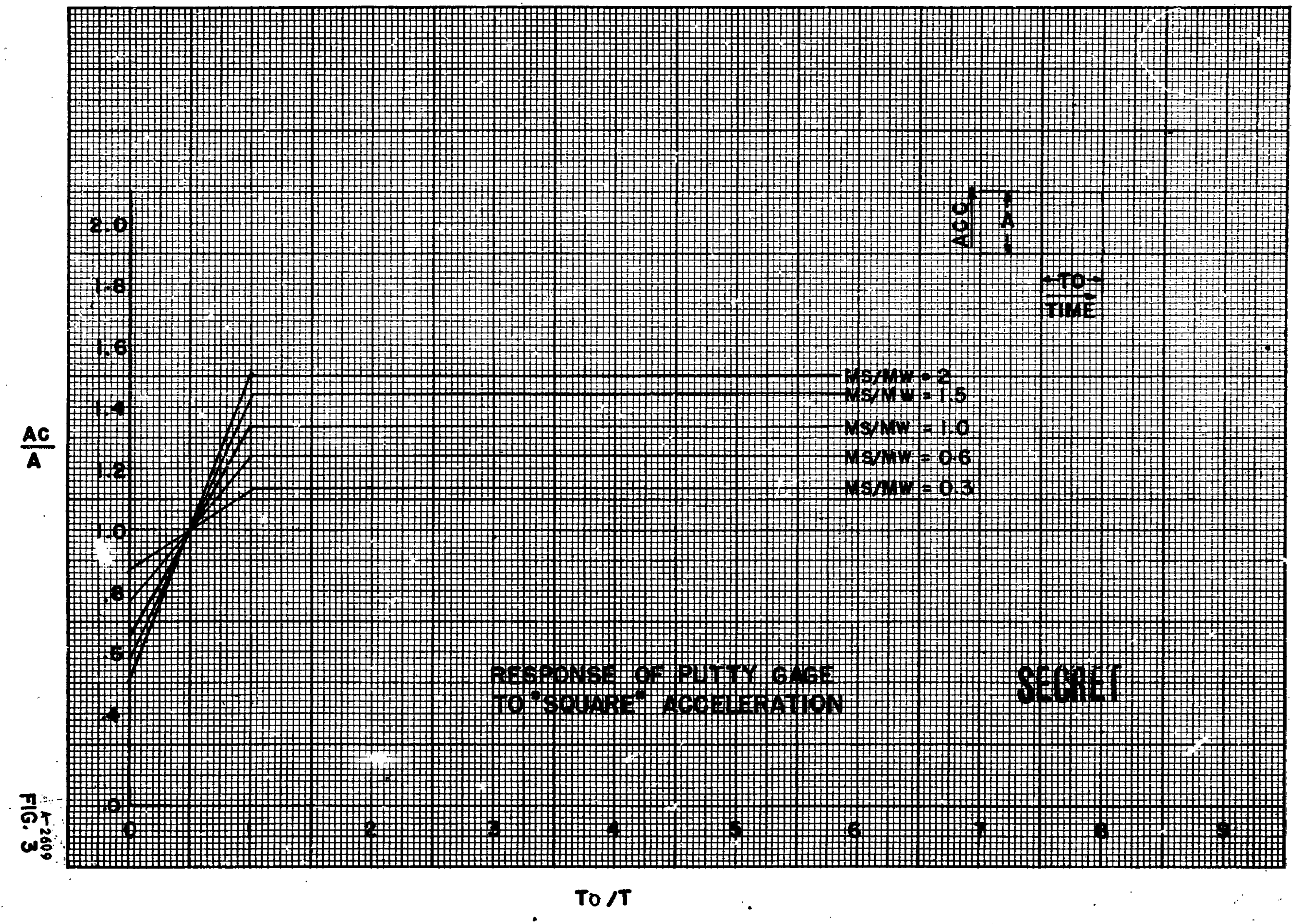
ACCURACY OF THE PUTTY GAGE

The assumption of a gradually applied acceleration in calculation of the critical acceleration is not valid for shock motions when the time required for severe fluctuations of the acceleration is of the same order of magnitude as the transit time of a stress wave through the spring. The curves of Figures 2 and 3 indicate the magnitude of the error to be expected when an acceleration pulse is short. In each curve A_c is computed by the formula of page 2; A is the actual peak acceleration of the gage frame. T is the time required for a longitudinal stress wave to pass from one end of the spring to the other; T_o is the duration of the pulse; and M_s/M_w is the ratio of the mass of the spring to that of the weight. T and M_s/M_w are listed in Columns 2 and 4 of Tables I and II. These curves were derived theoretically, using the assumption that indentation of the putty occurred as soon as the weight lost contact with the frame. Actually, the clearance between the cone point on the weight and the putty surface is about .001", which causes too low a reading for short duration pulses of acceleration. The only analyses available consider the two effects separately. The effect of clearance alone is indicated in Tables I and II by Column 5 (A_c/A when $T_o/T=1$) for a half-sine pulse, and Column 6 (A_c/A when $T_o/T=1$) for a square-wave pulse. If the two effects were combined, we would have curves resembling those of Figure 2 and 3 except A_c/A would be closer to 1 in the region $T_o/T>2$ and A_c/A would be very small as T_o/T approaches zero.


RESPONSE OF PUTTY GAGE TO
HALF-SINE WAVE ACCELERATION
MS/MW = 0.3
MS/MW = 0.6
MS/MW = 2
MS/MW = 1
AG/A
To/T
ACC.
TIME
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1
2
3
4
5
6
7
8
9

A-2609

FIG. 8



2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
0
AC
A
0
1
2
3
4
5
6
7
8
9
To /T
ACC
A
TO
TIME
MS/MW = 2
MS/MW = 1.5
MS/MW = 1.0
MS/MW = 0.6
MS/MW = 0.3
RESPONSE OF PUTTY GAGE
TO "SQUARE" ACCELERATION
SECRET

A-2609
FIG. 3

Thus the putty gage shows good accuracy for $T_o/T > 2$ and reads to low for shorter pulses. Fortunately, the stress produced in equipment is not proportional to acceleration when the pulse duration is much shorter than the natural period(s) of vibration of the equipment, but is more nearly proportional to the velocity change produced by the pulse. For this reason, an acceleration of 1000 g. of duration 1/2 millisecond will produce only slightly higher stress in most equipment than 500 g. of 1 millisecond duration. Therefore, the occurrence of low readings for short pulses are not of great practical significance.

A large error can be caused if resonant vibration of a putty gage spring is induced to transient vibration of the supporting structure. There resonant frequencies, F_s, are odd integer multiples of the values in Tables I and II, Column 3. There seems to be no reason why the stress fluctuation in the spring cannot built up to a value equal to the precompression of the spring, in which case an acceleration of less than one half A_c will cause indentation. The occurrence of resonance is expected to have been rare and, in order for it to be misleading, it had to permit premature indentation of particular elements. For example, if plungers 1, 2, 3, and 7 of a gage showed indentation, Number 7 would have been ignored. Also, resonance in spring number 1 is insignificant. Thus, while resonance can cause large errors, such errors are the result of a coincidence and therefore must have occurred in only a few gages.

Accidental indentation could have occurred in the two weeks prior to and after tests during which the gages were being installed or serviced at their test locations. Two cases of accidental indentation were found and corrected just prior to the Baker test, one due to straightening of some bulkheads of a destroyer with a sledgehammer and one due to firing of a small test charge near an APA. The chance that large errors due to jolting of structure near installed gages occurred is believed to be small. Except in the case of the small test charge, accidental indentations which were found did not exceed 100 g.

The error in interpolating between the critical accelerations of the plungers probably did not exceed ± 25 per cent of the interval between successive critical accelerations. The putty gages were usually in a group of other types of gage and their readings can be checked against those of the read, indenter, and velocity gages.

REED GAGE.

A multi-frequency reed gage contains eight flat spring steel strips, each of which is firmly clamped to the gage frame at one end and has a brass weight fixed to the other end. The fundamental natural frequencies of vibration of these reeds are 20, 40, 100, 210, 345, 430, 570, and 920 cycles per second, respectively. Motion of the reed tip relative to the gage frame is marked on a sheet of waxed paper fixed to the frame by means of scribers which are fixed to the reed tip. The record on the paper then shows the maximum deflection of the reed tip up and down from its neutral position.

The significance of the reed gage data is derived from the theory of the response of complex elastic (linear) structures to a given shock motion of the foundation of the structure. References 2 and 3 show that the distortion of the elastic structure may be considered to be made up by superposition of the natural modes of vibration of the structure. Also, the amplitude of each mode depends only upon the natural frequency of the mode, a factor depending upon where the shock motion is introduced, and the shock motion. If the elastic distortion of a single-degree-of-freedom system of a certain natural frequency, f_n, for a given shock motion is known, the distortion of a mode of a complex system which has the same natural frequency can be found. Thus, the reed gage records indicate the effect of the shock upon simple structures and comparison of records from different locations indicated the relative damage capacity of the shock at the different locations.

The reed gage record is plotted in this report as the ratio of maximum tip deflection to static deflection versus reed natural frequency. This is usually called a frequency-response curve. The static deflection of a reed is determined from its natural frequency f_n by the formula $\delta_s = \frac{4\pi^2 g}{f_n^2}$ and the maximum tip deflection x up and down for each reed is measured from the record. The ratio x/δ_s corresponding to a particular f_n then is the maximum number of "g" which a simple system having the same f_n would be subjected to by the shock.

The nature of the shock itself can be partially reconstructed from the reed gage record by comparing the frequency-response curve with the known curves for certain simple shocks. An "equivalent" simple shock which will produce roughly the same frequency-response curve can thus be selected. The value which x/δ_s approaches as f_n approaches infinity is the peak acceleration of the shock. Since the reed gage is very inaccurate for high values of f_n, this fact has been used to improve the accuracy of

the curve in this region by plotting the peak acceleration found by an adjacent putty gage at about $f_n = 1000$ cps.

The value of f_n at a maximum value of x/δ_s indicates the predominant frequency of the shock. Study of the frequency response curve for several types of simple shocks illustrated in reference 4 shows that the predominant frequency is approximately equal to the reciprocal of twice the duration of a single-pulse shock (half-sine wave, square wave, triangular wave, etc., of acceleration) or is equal to the frequency when the shock is a steady or transient vibration. The predominant frequency found for a reed gage on the shell of a ship should approximate the reciprocal of twice the duration of the explosion pressure wave. The predominant frequency for interior locations in the ship will be lower and indicate to what extent the intervening structure acts as a "shock mount" for interior equipment.

In addition to the frequency-response curves, the 20 and 40 cycle reed amplitudes are tabulated because they approximate the amplitude to be expected of shock mounted equipment and thus supplement the lead (x) gage measurements.

ACCURACY OF REED GAGES

There are several possible sources of deviation of reed gage performance from the theoretical ideal. Most important is the inaccuracy of measurement of the records. From experience in measuring these records, it is estimated that an accuracy of $\pm$ .01" is the best possible. The error in the curves plotted is therefore $\pm .01/\delta_s$. Since δ_s decreases rapidly with increasing f_n, the error probably amounted to several hundred percent for the highest frequency reed. The probable error is tabulated below for each reed.

f_n	Error in g	f_n	Error in g
20	.41	345	123
40	1.64	430	189
100	10.4	570	332
210	45.2	920	868

As mentioned before, the reading of an adjacent putty gage has been plotted on each frequency response curve to indicate the value of x/δ_s which the high frequency reeds should approach.

In a few cases, the amplitude of the low frequency reeds was so great that the scribers went off the edge of the recording paper. This is noted on the curves for the reeds to which this happened. The points plotted represent the distance to the edge of the paper. The actual x/δ_s was, of course, greater than that plotted.

The reeds are not pure single-degree-of-freedom systems as is required by theory since they have many natural frequencies above the fundamental and they are nonlinear at high amplitudes. The record of motorized reed gage R"3 of the DD408 on test Baker shows clearly an example of simultaneous excitation of two natural frequencies of the 20 cps reed. The next higher natural frequency observed is estimated from this record to be 350 cps. Due to the high ratio of the higher frequencies to the fundamental, and as the displacements caused by the higher frequencies are small, it is assumed that the contribution of higher harmonics to a reed is negligible.

It is known that the assumption that the reed tip deflection will be the same as the deflection of a mass-on-weightless-spring system of the same natural frequency is not valid. This error is in addition to the effect described in the preceding paragraph and is due to the fact that the scriber is located at the center of the brass weight while the point at which the mass should be considered to be concentrated is closer to the base of the reed. This error increases as the mass of the reed becomes larger relative to that of the brass weight. The readings used in this report are all actual reed deflections and are therefore larger than would have occurred with the more theoretically desirable mass-on-weightless-spring system. Factors by which the reed deflections should be multiplied to convert to the simple mass-spring system deflections have been obtained from experiments subjecting a reed gage to known simple shocks. While these factors may be subjected to revision, they are tabulated below in Table III to indicate the relative magnitude of error only. It is of interest to note that the factor

f_n	Factor	f_n	Factor
20	.98	345	.68
40	.94	430	.65
100	.86	570	.68
210	.78	920	.614

for the first mode of a simple cantilever (no brass weight) is, by theory, equal to .64. The effect of the higher modes would be to make this factor somewhat greater.

The motion of the reeds was damped by the friction of the waxed paper which tended to reduce the reed amplitude, particularly in the case of resonance of a reed frequency with a transient vibration. The amount of damping is indicated on motorized reed gage records at the end of Section IV, which were made by dropping the gage onto a heavy steel anvil. Measurement of the decrement shows that the decrement per cycle is independent of amplitude, which is characteristic of Coulomb damping. Typical measurements are tabulated below in Table IV for those reeds which could be measured.

TABLE IV

f_n	Decrement/cycle inches	Decrement/second in/sec.
20	.132	2.65
40	.115	4.60
100	.014	1.40
210	.004	.82

The reed gages had about the same chance for accidental excitation as the putty gages.

MOTORIZED REED GAGES

The motorized reed gages are identical to the reed gages, just described, except that the spools of recording paper had electric-motor drives which were started just before the test explosions. The records obtained showed the variation of reed amplitude with time. The time scale was not recorded separately on the paper but could be estimated from the transient vibrations of the reeds.

The records obtained were used to plot frequency-response curves just as was done with the non-motorized gages. Some of the more interesting records are reproduced in Section IV.

The accuracy of the motorized reed-gage record is the same as for non-motorized reed gage except no error due to accidental excitation could occur.

INDENTER GAGE

The indenter gage was designed as a peak-reading accelerometer. Figure 4 shows the essential details of such a gage. The mass M is guided by case C and rests against the hardened steel pins B. The end of B in contact with M is cut square, but the other end has a 90° conical point and just contacts the flat surface of a soft aluminum plug P.

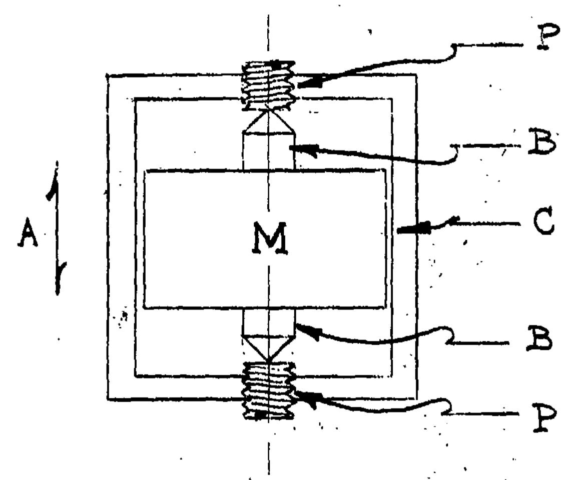


Figure 4

When the case C is accelerated up or down, the inertia of M causes a cone point to be pressed into its aluminum plug. It has been shown for static tests that the depth, d, of penetration of the cone point into the aluminum is related to the applied force F by the formula $F = Rd^2$ where R is an empirical constant. Further, the depth of penetration is uniquely related to the crater diameter of the impression. Assuming that the static law $F = Rd^2$ applies under dynamic loading conditions, we can find the peak acceleration of the mass M from a measurement of crater diameter and a curve of F/M versus crater diameter. However, we are interested in the peak acceleration of the gage case, not that of the internal mass. While the two are equal for a gradually attained steady acceleration, they can be very different for rapidly fluctuating accelerations.

A theoretical analysis of an indenter gage with values of M and R the same as those for the gages used at Bikini has been made by Dr. Paul Symonds of NRL for the case when the gage base undergoes a half-sine wave pulse of acceleration with a peak value of A_p and a duration T. The curves resulting from this analysis are shown in Figure 5.

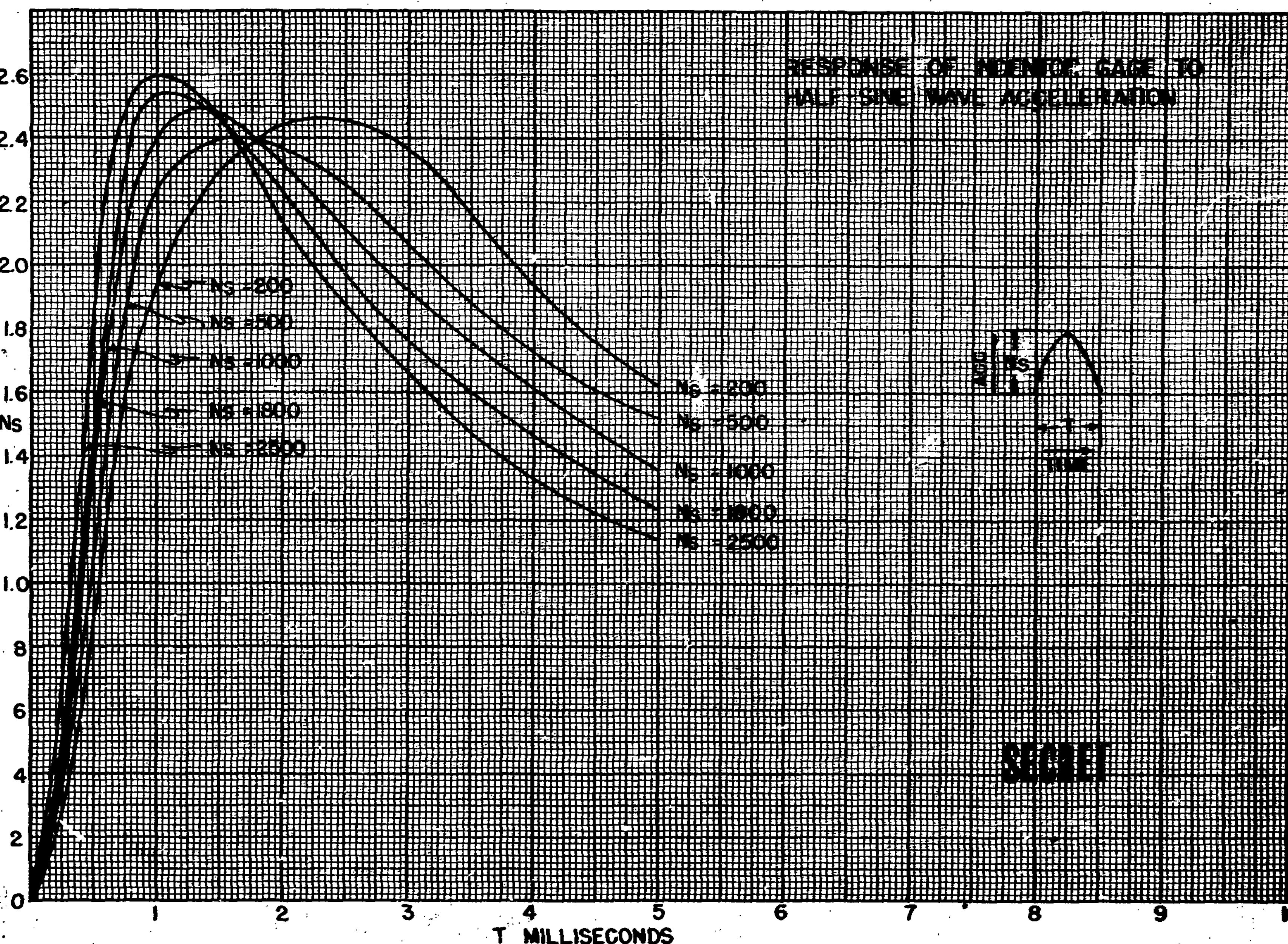

RESPONSE OF INDENTOR GAGE TO
HALF SINE WAVE ACCELERATION
N/Ns
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
1
2
3
4
5
6
7
8
9
10
T MILLISECONDS
Ns = 200
Ns = 500
Ns = 1000
Ns = 1800
Ns = 2500
ACC
Ns
T
TIME
SECRET

FIG. 5 A-2609

The gage reading is too low for $T < 1/2$ millisecond and is about 2-1/2 times too high for T in the vicinity of 1-4 milliseconds. At larger values of T, the reading approaches the true value.

When the shock consists of a transient vibration, it can be readily seen that the mass M will lose contact with the pin as soon as the acceleration of the base reverses its direction. The mass will "rattle" back and forth between the pins a large number of times. Each impact is theoretically capable to increasing the indentation of the aluminum regardless of how large it may be already. Therefore, no theoretical upper limit can be placed on how much too high the gage will read.

In the gage used, The central mass M was supported by six pins rather than two so that the peak acceleration of the mass would be recorded in both directions for each of the three rectilinear axes of the gage. The orientation of the gage axes relative to those of the ship were recorded. The data tabulated for a gage gives the peak acceleration of the mass calculated by the method outlined above for each of six directions. Each direction gives the bearing and elevation of the acceleration vector. It was not possible to convert these vectors into a set parallel to the principle axes of the ship because it was not determinable whether these vectors were components of some diagonal vector or were the principle vectors of a shock whose direction of motion changed with time.

ACCURACY OF THE INDENTER GAGE

It has been shown in the preceding paragraphs that the indenter gage may be inaccurate for shock motion of the type to be expected. It should be noted however, that the gage will always read too high unless (1) $T < 1/2$ millisecond, or (2) if the force required for indentation is greater for dynamic than for static loads. It is believed that T was not less than 1/2 milliseconds at the locations where indenter gages were placed. For Baker shot, T would certainly be greater than 5 milliseconds at the locations (in superstructure areas) of the indenter gages. For Able shot, where the blast duration was in the order of a second, it would also be expected that T would be greater than 5 milliseconds. The error involved in above statements will be overshadowed by the other errors already discussed.

Another source of error was the fact that some indentation was unavoidable during assembly of the gage. These usually correspond to about 20 to 50 g so one can be reasonably certain that readings over, say, 100 g were due only to shock.

It should be concluded that the values of acceleration determined from indenter gage readings were somewhat greater than the actual peak accelerations for associated frequencies less than 1000 cps.

SHOCK RECORDING GAGE

The shock recording gage is essentially equivalent to a refined, single-element, motorized reed gage. As shown in the photographs (283-286) of the installed gages, a mass and coil-spring system is used instead of a reed, and motion of the mass relative to the gage frame is marked on a strip of waxed paper which is drawn under the stylus by a motor-driven spool. Time intervals are indicated by firing a spark through the paper at about ten millisecond intervals.

A detailed analysis of these records cannot be made at this time. The acceleration-time curve of the gage base may be obtained from the record by application of the equation $\ddot{X} = w^2u + \ddot{u}$, where $\ddot{X}$ is the acceleration of the base, w is the natural frequency of the mass-spring system in radians per second, u is the relative motion recorded by the meter, and $\ddot{u}$ is obtained by double differentiation of u with respect to time. Formulas for the velocity, $X = W^2 \int u\,dt + \dot{u}$, or the displacement, $X = W^2 \iint u\,dt\,d_t + u$, may be used if preferred. Copies of some of the records are included in this report in Section IV.

VELOCITY METER

The velocity pickup used was originally designed by the British and was extensively used on their "Cameron" trials. Modifications of this instrument were made by the David Taylor Model Basin group and a more detailed description of this instrument can be found in their reports. The essential features of the unit are

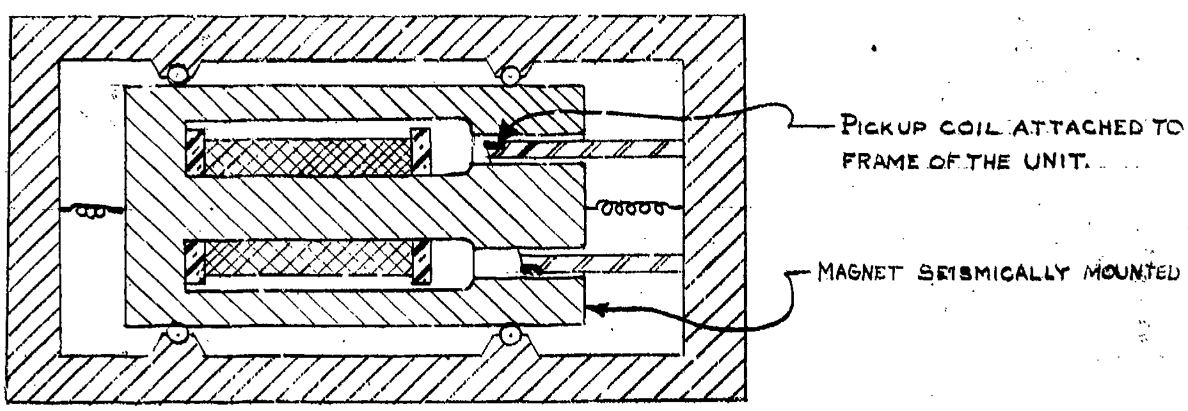


Figure 6. "British Type Velocity Meter."

illustrated in Figure 6. The velocity pickups and their recording systems reported here were operated by personnel from the Bureau of Ships and from the Norfolk Navy Yard.

The system of recording employed was frequency modulation of the signal impressed on a wire recorder. A central or carrier frequency of about 4500 cps. was used. The system of recording and the velocity meter were capable of responding with reasonable fidelity between a frequency range extending from about 10 cps to over 1000 cps. However, it is evident, from the study of the records, that the wire in passing through the recorder suffered transient longitudinal vibrations which effectively caused a considerable background frequency modulation to be impressed upon the record. This background was generally between 15 to 25 per cent of the full scale deflection. As a result, only records for which the real velocity changes were greater than 25 per cent of full scale were noticeable as such. For records in which full scale deflection occurred, the error is estimated to be no greater than 25 per cent. It should be remarked that the principal of recording is excellent and should afford good results if employed with a recorder built with this method in mind.

In inspecting the velocity meter records, the effect of the springs and bottoming of the magnet must be considered. The springs cause a low frequency oscillation of the record at less than 10 cps. When the magnet bottoms against the base of the meter, a sudden reversal of the signal occurs which is rather easy to detect. The stop in the other direction is the relatively flexible top of the meter cover which reverses the signal in a time which is not short relative to the shock motion changes. The magnetic field at the pickup coil drops from full strength to about 50 per cent of full strength as the magnet moves through the last 1/8" to the top stop. The effect of this is to make the meter cover seem even more flexible and make this bottoming difficult to detect. The magnet bottoms after travelling zero or two inch (nominal travel between stops) after a previous bottoming. The travel to a stop from the rest position of the magnet is about one inch. By integration of the velocity-time record, the times at which bottoming will introduce a spurious record can be found. One can also find the direction of motion with respect to the front and back of the pickup unit, by noting whether a velocity results in a hard or soft bottoming of the meter.

SECTION III

INSTRUMENTATION PLAN

Objectives. In order to present the objectives of this work, it is necessary to describe the things that occur in a ship's structure when the ship is subjected to a pressure wave resulting from an explosion. This has been described excellently in Reference 6, Section 3, and it is quoted here:

"When a pressure pulse from a non-contact underwater explosion reaches a ship, its first effect is to cause or tend to cause a certain amount of elastic distortion of the hull. This effect can be sub-divided into two parts. First, the shell plating between frames will be dished inwards, and second, there will be an inward movement of the ship's side or bottom as a whole.

"When the pressure in the pressure pulse is reduced, the elasticity of the shell plating and the ship's framing will tend to cause these items to return to their original shape, provided their elastic limit has not been exceeded and both shell plating and framing will oscillate until their energy is exhausted.

"Internal structures which are connected to the hull will therefore be subjected to forces caused by the movement of the shell plating and framing as a result of underwater explosions. These forces will cause the structures to oscillate, the actual characteristics of the movements depending on the mass and stiffness of the loading structure, the mass of the shell plating, framing and entrained water, and the stiffness of the shell plating and framing.

"Decks and bulkheads which are not in direct contact with the hull below the waterline will receive shock forces via structures linking them to the hull below the waterline. These structures, by virtue of their mass and flexibility, will tend to reduce the shock forces transmitted to such decks and bulkheads."

The objectives of the instrumentation was to determine the characteristics of the motion of the various parts of the ship due to the pressure wave resulting from the explosions of the atomic bombs. Since it is these shock motions of the structures which cause damage to equipment attached to these structures, it is necessary in order to design equipment and shock mountings to determine the shock motions to which equipment is subjected. Summaries of the instrumentation plans for the various types of ships follow.

I. DESTROYERS

The Destroyers chosen for instrumentation were those which were in the westerly string. Two ships, the DD404 and the DD408, were instrumentated much more completely than the other ships in the string. Putty gages, reed gages, and velocity meters were installed throughout these two ships, starting in the aft fire room on the keel top, then on external frame numbers in the same compartment. In the engine room, gages were installed on the following foundations: The main switch board, low pressure turbine, and the turbo-generator. It was considered that these gages would give data that was representative of conditions below the main deck.

The second group of gages installed on the DD404 and 408 were those in the superstructure. Gages were installed on frame numbers on both the first and second superstructure deck level, in the main battery fire control director, and the radar antenna mounting brackets at the top of the fore mast. Only putty gages were installed at the top of the fore mast but in all other locations clusters of gages made up of putty gages, reed gages, and velocity meters were installed. The objective of the instrumentation of the DD404 and DD408 was to determine the characteristics of the shock in various parts of the ship due to the explosion. One sort of thing which this data would yield would be the relation between the shock experienced by equipment which was installed on foundations attached to the hull numbers and the shock experienced by equipment in the superstructure. It was hoped that an empirical relationship could be extablished concerning the characteristics of the shock delivered to the keel as compared to the shock transmitted to various other parts of the ship as one moved up from the keel through the structure to the main battery director and then to the masthead.

In addition to the gage mentioned above, for the B shot, four shock recording gages per ship were added. These gages were located close to the "A" shot gages as follows: One on the keel top, one on an external frame number 5' below waterline, one on frame 5' below main deck, and one on the low pressure turbine foundation.

On the remainder of the ships in this Destroyer string, putty gages and reed gages were installed on the keel and on a frame number in the fire room and two putty gages were installed in the superstructure. The gage locations were selected on each ship to be as much similar to the locations on the DD404 and DD408 as possible. These gages were essentially range gages. The results would give data on the shock characteristics as a function of the distance of the ship from the explosion.

Since these range gages were in locations which were similar to those on the ships which had a more complete instrumentation, it was considered possible to draw conclusions concerning the shock characteristics throughout the ship with the data from the range gages and the conclusions drawn on shock propagation through the ships structure as a result of the analysis of the data from the gages on the DD404 and DD408.

II. SUBMARINES

The instrumentation plan for the submarines was similar to the plan for the destroyer instrumentation in that two of the target ships had a relatively large number of gages installed to give data on the transmission of shock through the structure of the ship while the remaining six ships had but two gages, each installed to give data on the intensity of shock as a function of distance from the explosion.

In all eight ships the range gages, one putty gage and one reed gage, were installed on the flange of a hull stiffener in the torpedo room and on the side of the ship which was closer to the explosion. Except for the SS308 and the SS335, this constituted the instrumentation. However, in the cases of the SS308 and SS335, in addition to these range gages, twelve putty gages were installed in each ship to give data on the characteristics of the shock occurring in various parts of the ship. The locations of these gages were as follows: In the engine room on the generator foundation, in the maneuvering room on the supports for the control cubical and also on the control cubical, in the control rooms on bulkhead stiffeners, in the conning tower on the external plates, and on frame and deck beams in the torpedo rooms. The objective of the instrumentation was to obtain data on the characteristics of the shock to which equipment, in the several types of structure of which a ship is composed, was subjected due to the explosion.

CAPITAL SHIPS

The capital ships instrumentated were the battleships USS NEW YORK AND USS NEVADA, and the cruisers USS SALT LAKE CITY and the USS PENSACOLA. These ships were treated individually and not as a group of practically indentical structures as were the destroyers and submarines.

The gages installed were putty gages and reed gages and the locations were chosen with the same view in mind as in the case of the destroyers, namely, to give information concerning the propagation of shock through the structure of the ships.

ages were installed on the hull well below the waterline on a member or some rigid structure attached to the large stru... nbers of the hull in interior compartments above the waterl... well as in the superstructure.

APA INSTRUMENTATION

Very little instrumentation was attempted on the APA's. For the "A" shot, two ships, the APA64 and APA65, has instruments installed, and on the "B" shot the APA87 was added. The instrumentation consisted of putty gages installed on the foundations of equipment. Two gages were installed on external hull frame members, one gage below the waterline and one above the waterline. The others were installed on the following foundations: Main switchboard, main motor, and main generator.

All that was intended to be found from these gages was the peak value of the acceleration which would be guide and check to be used in the analysis of the data from the velocity meters which were adjacent to these putty gages.

REFERENCES

1. I. Vigness, E. W. Kammer, and S. G. Holt, "Shock and Vibration Instrumentation and Measurements, Second Partial Report." RESTRICTED Naval Research Laboratory Report 0-Z645.

2. M. A. Biot and R. L. Bisplinghoff, "Dynamic loads on airplane Structures During Landing" N. A. C. A. Advance RESTRICTED Report No. 4H10.

3. M. A. Biot, "Analytical and Experimental Methods in Engineering Seismology", American Society of Civil Engineers Transactions Paper No. 2183, or Proceedings January, 1942.

4. J. M. Frankland, Ph. D., "Effects of Impact on Simple Elastic Structures" David W. Taylor Model Basin Report 481, RESTRICTED.

5. "Shock Effects from Underwater Explosions" Report on Trials in H. M. S. "Cameron" Carried out by the British Admiralty Shock-In-Ships Committee July, 1942 to September, 1943 BR1314 RESTRICTED.

6. Director of Ship Material, Joint Task Force One, Bureau of Ships Group. "Interim Report for Test Able", and "Interim Report for Test Baker." SECRET

SECTION IV

GAGE LOCATIONS AND DATA

The data is arranged by ships in the following sequence: destroyers, submarines, attack transports, cruisers, and battleships. Ships of a class are in numerical order. Following the data for each ship and class of ships is a discussion of that data.

The following notes explain some of the notation and symbols used in that data.

Note 1. The lowest critical acceleration for the low range putty gage is 20g.; the lowest for the high range gage is 50g. When no indentation was found, the acceleration is recorded as less than 20g. or less than 50g.

Note 2. The orientation of a gage is described as "directed up", "direct to port", etc. "Directed up" means that the gage body is above the mounting base, "directed to port" means that the gage body is to port of the mounting base, etc. A putty gage records only the acceleration vector or its component which is directed in the same sense as the gage.

Note 3. The reed gage deflections are described as "up" meaning toward the top of the gage or "down" meaning toward the mounting base. On the frequency-response curves "up" and "down" refer to the direction toward which the reed deflected even though the accelerations plotted are those of the brass weight and therefore have an opposite direction.

Note 4. Directions indicated in the tables of indentor gage readings are the directions toward which the accerlation vectors are pointed.

Note 5. The following abbreviations and symbols are used:

- G   Putty gage
- R'   Reed gage
- R''   Motorized reed gage
- V'   Velocity meter
- Q   Indentor gage
- O   Shock displacement gage
- g   Acceleration of gravity = 32.2 ft/sec.^{2}

f_n	Natural frequency of vibration in cycles per sec.
c.p.s.	Cycles per second
d_s	Static deflection, or the deflection corresponding to a steady acceleration of 1g.
A	Test Able
B	Test Baker

Note 6. Motorized reed gage records for Baker showed several successive shocks but it was not possible to separate the records into a consistent number of pulses. However, the last pulse, due presumably to air blast, was always distinguishable. In preparing frequency-response curves from these records, the maximum amplitudes in the air blast shock record have been labeled "wave 2". Maximum amplitudes due to the preceding group of shocks, presumably water-borne, are labeled "wave 1".

Note 7. The bearing listed for each ship in the comments on that ship is the bearing of the explosion relative to the ship.

Note 8. DSM reports on shock damage to ships are taken from reference 6.

Note 9. Photos of gage locations referred to are in the Photographic Volume of this group of reports.

Note 10. Numbers (1), (2), or (3) following the letter "A" (test Able data) are estimates of the relative shock intensity to be expected at the gage locationand are defined in Section V, DISSCUSSION OF DATA - TEST ABLE.

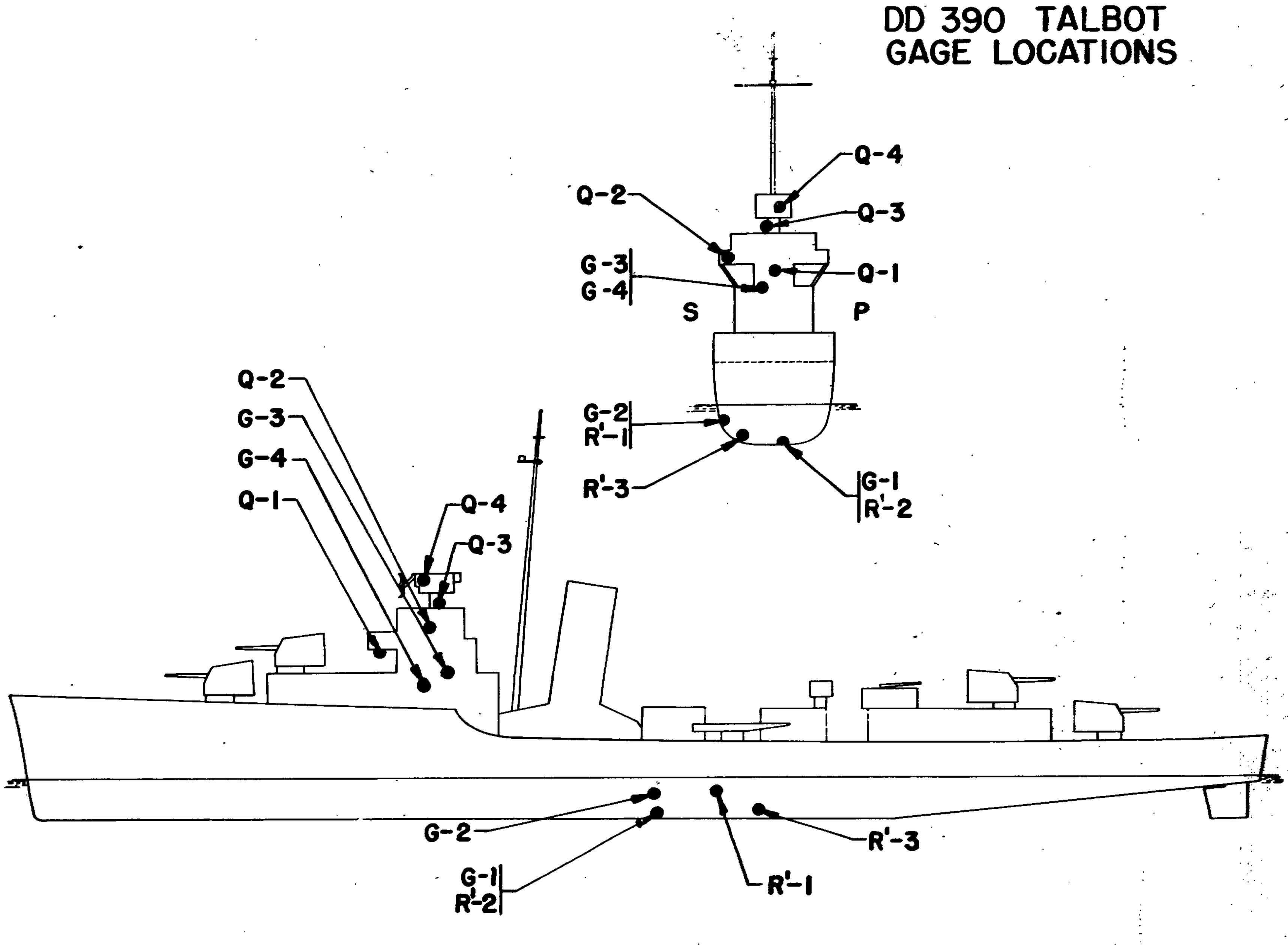

DD 390 TALBOT
GAGE LOCATIONS
Q-4
Q-2
Q-3
G-3
G-4
Q-1
S
P
G-2
R'-1
R'-3
G-1
R'-2
Q-2
G-3
G-4
Q-1
Q-4
Q-3
G-2
G-1
R'-2
R'-1
R'-3

FIG. 7

A-2609

DD390 - USS RALPH TALBOT

Putty Gages

G1 - Photo 252. In fireroom compartment B-2-1. Directed up on top of keel at frame 99. Note: Cast iron ballast ingots cover the hull plates for about 2 1/2 ft. either side of keel.

A. (3) 75g. B. 300g.

G2 - Similar to photo 262. In fireroom, compartment B-2-1. Directed inboard normal on flange of Frame 99, 4 ft. below upper grating level on starboard side.

A. (3) less than 50g. B. 60g.

G3 - Similar to photo 291. In C.I.C. room, directed up on deck at frame 62. 5 in. inboard from starboard bulkhead.

A. (2) 60g. B. 100g.

G4 - Photo 253. In passage-way A-0101-36 just forward of ships Office. Directed to port on overhead beam at frame 58. 3 ft. to starboard of ship centerline.

A. (2) 110g. B. 100g.

Reed Gages

R'1 - Similar to photo 260. In fireroom, compartment B-2-1. Directed inboard, normal on flange of starboard frame 100, 4 1/2 ft. below upper grating level.

Graph	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (3) Fig. 8	.105	.10	.02	.04
B. Figure 9	.02	.03	0	0

R'2 - Photo 252. In fireroom compartment B-2-1. Directed up on frame 99 flange. About 1 ft. to starboard of keel centerline.

	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (3) readings all zero.				
B. Figure 10	.10	.07	Record torn	

R'3 - Photo 254. In fireroom compartment B-2-1. Directed forward on aft starboard support of aft boiler, frame 105.

A. Readings all zero

B. Readings all zero

Indenter Gages

Q1 - Photo 255. On underside of Mk. 51, 20 mm gun director platform. Directed down at intersection of 3" I-beam (about frame 55) and 3" stiffener (on ship centerline). Director platform is just forward of C.I.C. room.

A		B	
Up	85g.	Up	50g.
Dn.	65	Dn	70
40°	760	65°	300
130°	280	155°	390
220°	410	245°	330
310°	615	335°	440

Q2 - Photo 256. On Navigating Bridge deck directed up on deck, 2 in. from base of starboard Mk. 27 torpedo director. Approx. frame 66 1/2.

A		B	
Up	230g.	Up	65g.
Dn	220	Dn	65
75°	1270	60°	40
165°	135	150°	35
255°	1550	240°	65
345°	65	330°	60

Q3 - Photo 257. On top of pilot house. Normal on flange of aft starboard brace of base of Mk. 33 gun director.

A					B				
brg.	19°	elev.	28°	250g.	brg.	41°	elev.	28°	155g.
brg.	54°	elev.	-55°	90	brg.	120°	elev.	20°	60
brg.	120°	elev.	20°	20	brg.	174°	elev.	55°	95
brg.	199°	elev.	-28°	260	brg.	221°	elev.	28°	220
brg.	246°	elev.	55°	70	brg.	300°	elev.	-20°	35°
brg.	300°	elev.	-20°	20	brg.	356°	elev.	55°	80

Q4 - Photo 258. Inside turret of Mk. 33 gun director above pilot house. Directed upon top of port arm of forward U-bracket.

A		B	
Up	50g.	Up	40g.
Dn	30	Dn	30
70°	165	0°	60
160°	40	90°	130
250°	15	180°	55
340°	20	270°	185

COMMENTS

Test Able   Range 3735 ft.   Bearing of burst 139°

The putty and reed gages were not on surfaces exposed to air blast and therefore gave small readings. G4, horizontal within the superstrucuture, probably gave a representative reading (110g.) for interior superstructure locations while readings for locations below the waterline show negligible values. R'1 vertical on the keel shows a low-frequency excitation of about 200-300 cps.

Some indenter gages (Q1, Q2, and Q3) showed very high readings. This is partially in accord with the fact that they were on structures which were struck directly by air blast. Q2 showed its high reading in a direction parallel to the free-air shockwave front which might possibly be due to reflection of the wave from the superstructure. Q2 in particular shows equal high readings in opposite directions which indicates that rattling of the weight caused most of the reading 200-500g. seems to be a reasonable estimate of the peak acceleration of exposed ordnance equipment. Q4 within the gun directer shows a reading of less than 165g. in accord with that of G4 within the superstructure.

Test Baker   Range 5450 ft.   Bearing of burst 265°

The gage locations were planned for direct exposure of the starboard side to the shock waves while the wave actually struck the port side.

The gages below the waterline registered a higher shock at the keel than on the hull away from the blast. The 300g. reading of the keel putty gage is not well substantiated by the adjacent reed gage. However, in consideration of the poor reed gage accuracy at high frequency, the apparent disagreement is explainable if the shock pulse duration is less than 1 millisecond.

The superstructure gages all show vertical accelerations of 100g. or less. Since the 100g. vertical reading occurred on the putty gage in the C.I.C. room and the exposed indenter gages read less vertically, it seems probabe that the origin of the vertical shock was underwater pressure waves. Q1, exposed to air blast, had a 400g. horizontal reading; Q2 was shielded from air blast and had readings below 60g. Q3 was partially exposed to air blast and had a 220g. reading; and Q4 within the gun director had a 130g. reading. These readings indicate that shock due to both air and water blast waves was felt in the superstructure; the horizontal reading due to airborne pressure and the vertical due to waterborne waves. 100-300g. seems a fair figure to assign to shock in exposed ordnance equipment.

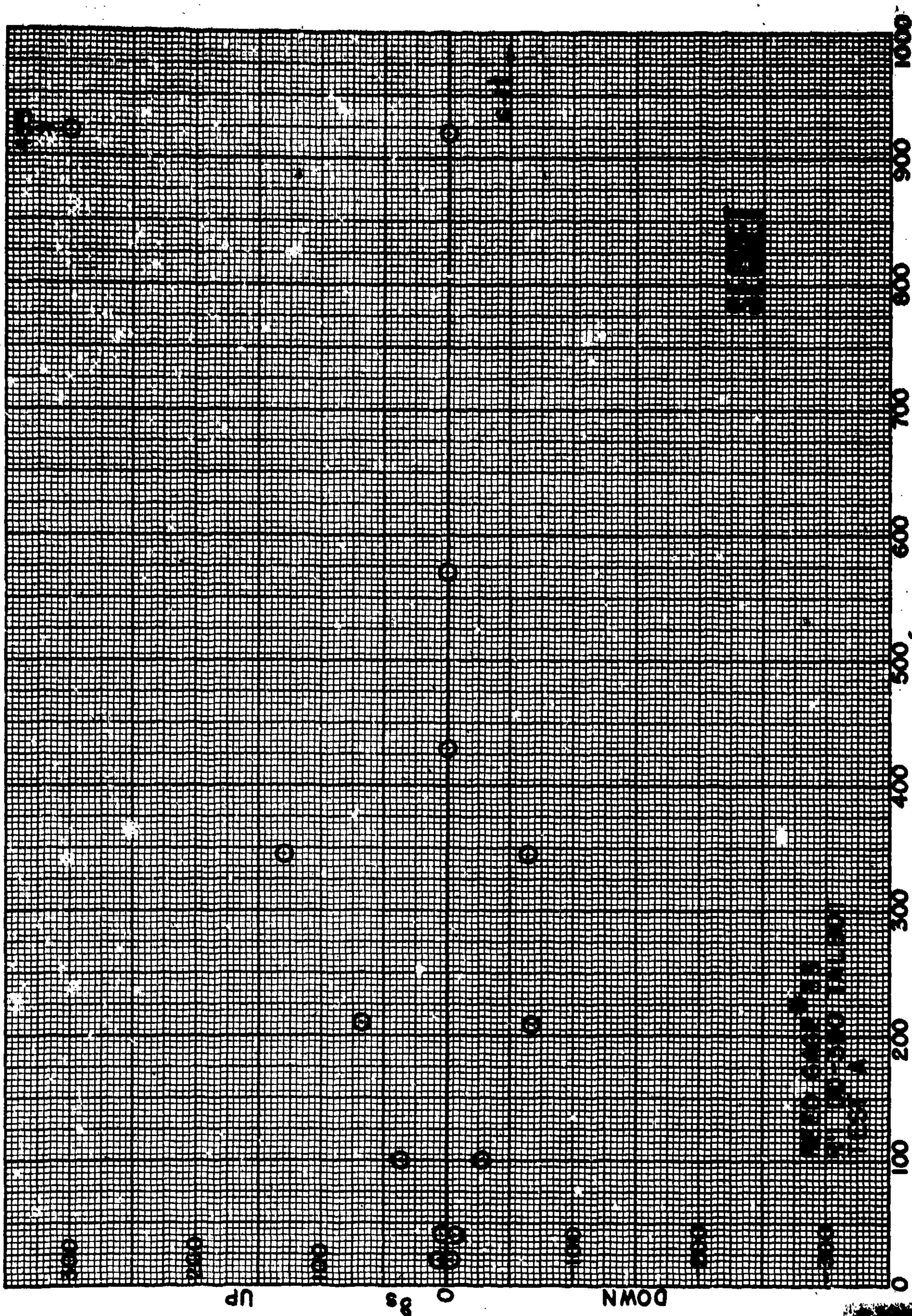
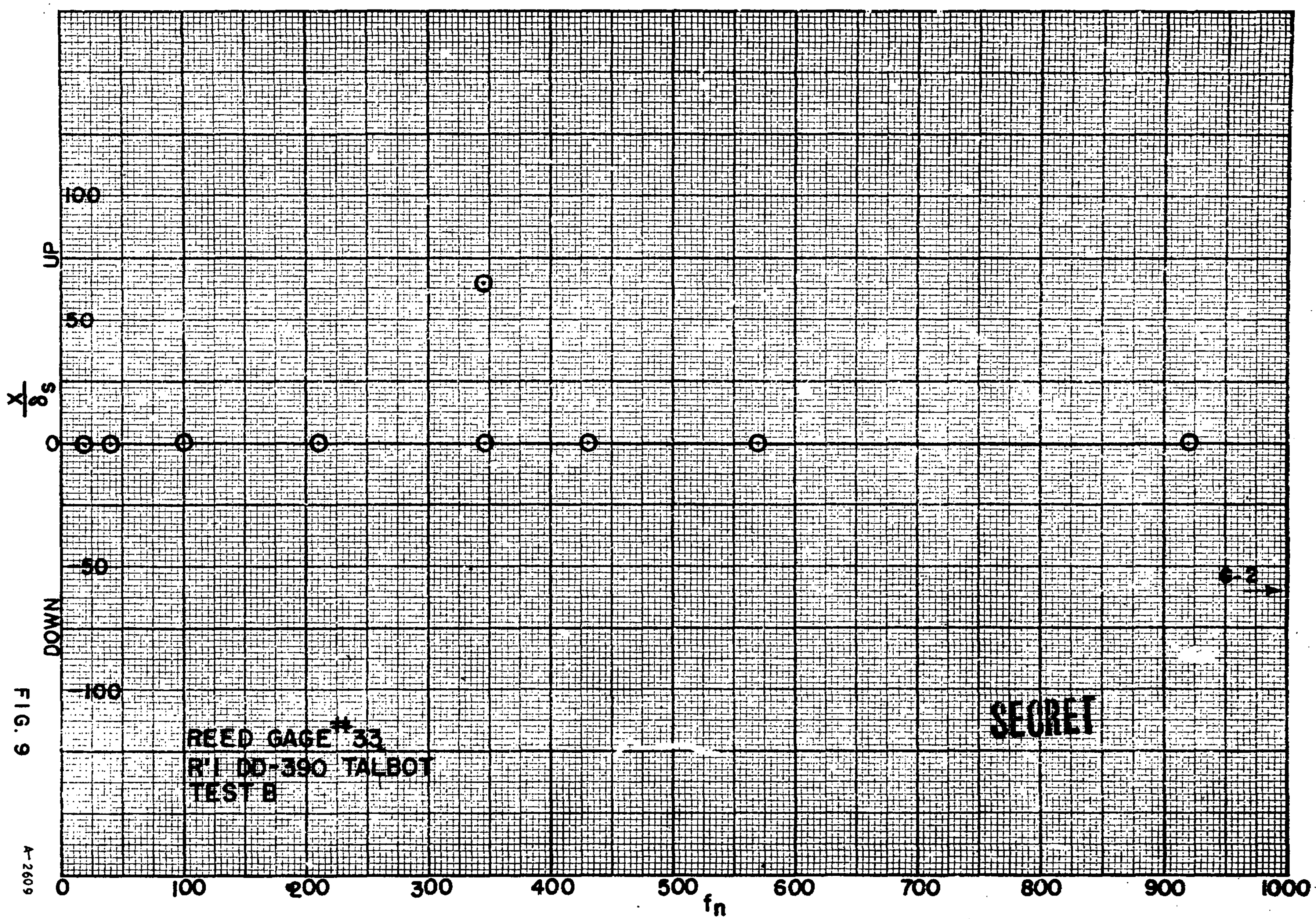

0
100
200
300
400
500
600
700
800
900
1000
f_n
UP
DOWN
$\frac{X}{\delta_s}$

FIG. 8



UP
DOWN
$\frac{X}{\delta_s}$
100
50
0
-50
-100
REED GAGE #33
R'I DD-390 TALBOT
TEST B
SECRET
6.2
0
100
200
300
400
500
600
700
800
900
1000
f_n

FIG. 9

A-2609

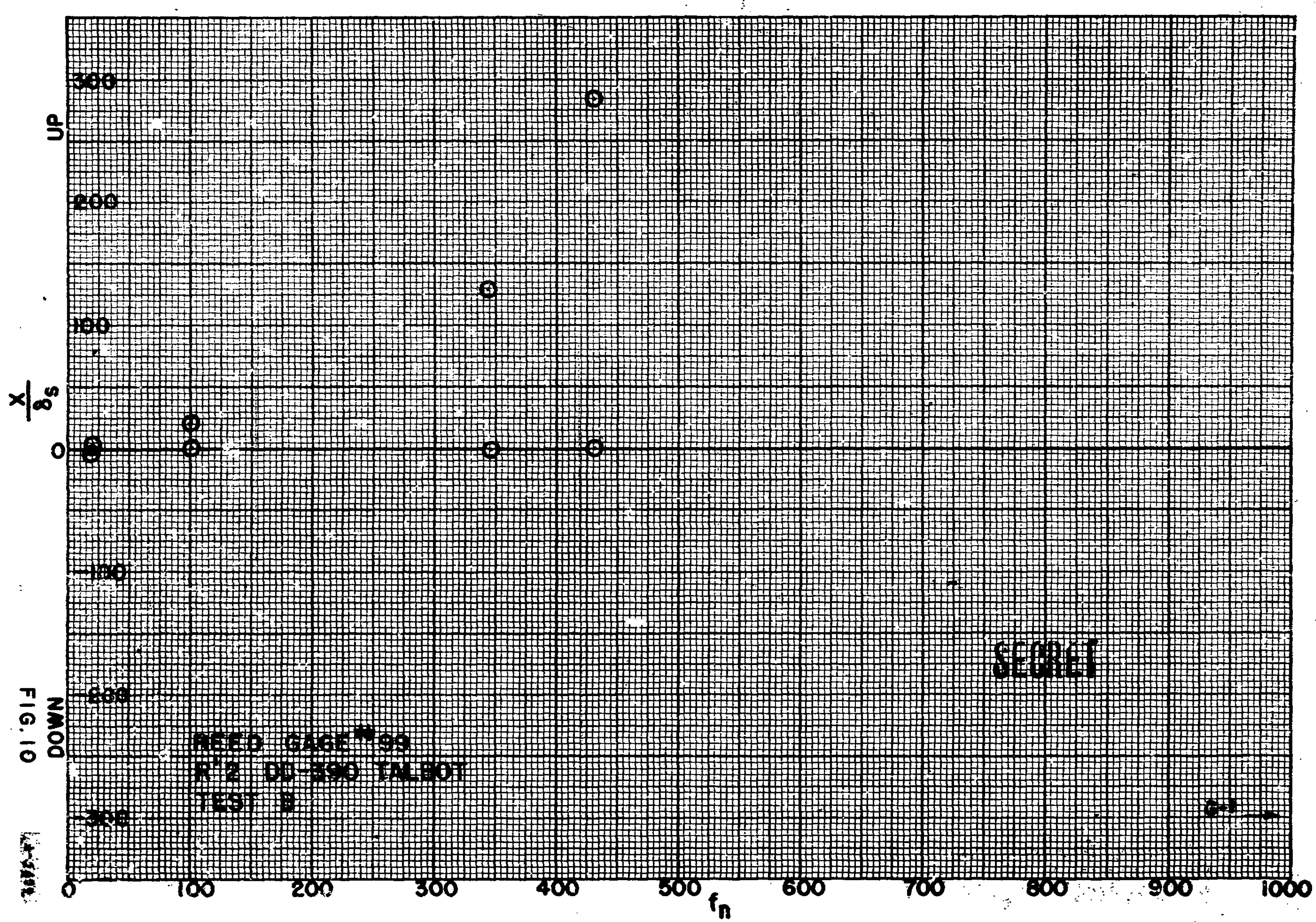

UP
300
200
100
0
-100
-200
-300
DOWN
$\frac{X}{\delta_s}$
0
100
200
300
400
500
600
700
800
900
1000
f_n
REED GAGE #99
R'2 DD-390 TALBOT
TEST B
SECRET

FIG. 10

DD402 - USS MAYRANT

Putty Gages

G1 - Photo 259. In aft fireroom, compartment B-2-1. Directed inboard, normal on flange of starboard frame 101, 4' below upper grating level.

A. Not installed. B. 75g

G2 - Similar to Photo 262. In aft fireroom, compar[illegible]t B-2-1. Directed up on top flange of keel, 56 in. forward of bulkhead 104.5.

A. Not installed. B. Less than 50

G3 - Similar to photo 291. In C.I.C. room. Directed up on deck over the beam at frame 59 6 in. inboard from starboard bulkhead.

A. Not installed. B. 300g.

G4 - Similar to photo 271. In C.I.C. room. Directed to port on bracket on deck over beam at frame 60. 6 in. inboard from starboard bulkhead.

A. Not installed. B. Unreadable

Reed Gages

R'1 - Photo 260. In aft fireroom, compartment B-2-1. Directed inboard, normal on flange of starboard frame 97. 4 ft. 6 in. below upper grating level.

	Graph	20 cps		40 cps	
		Up	Dn	Up	Dn
A.	Not installed				
B.	Figure 12	.47	.495	.17	.135

R'2 - Similar to photo 262. In aft fireroom, compartment B-2-1. Directed up on top flange of keel, 66 in. forward of bulkhead frame 104.5.

A. Not installed

B. Not installed

DD 402 MAYRANT
GAGE LOCATIONS

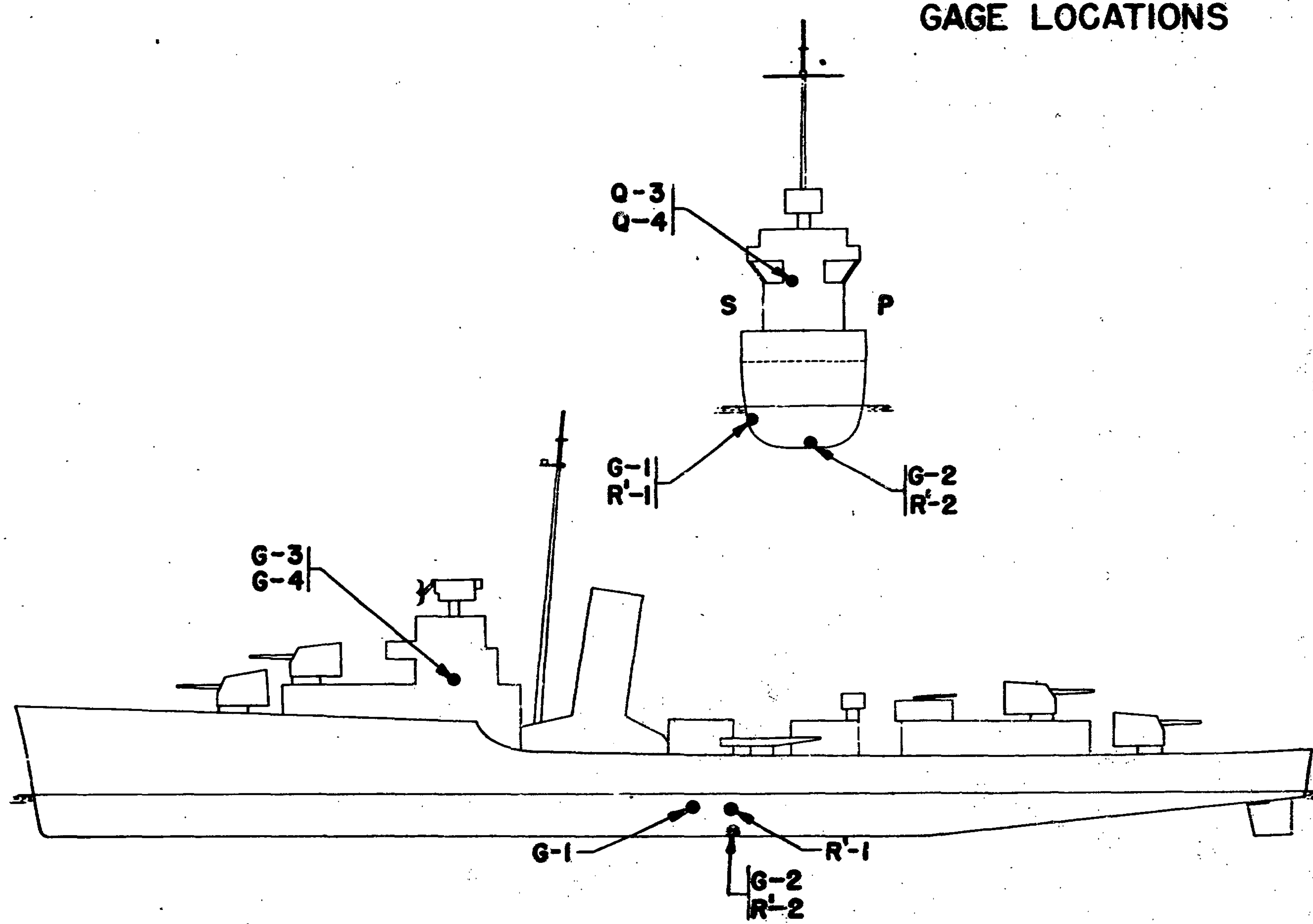


FIG. 11

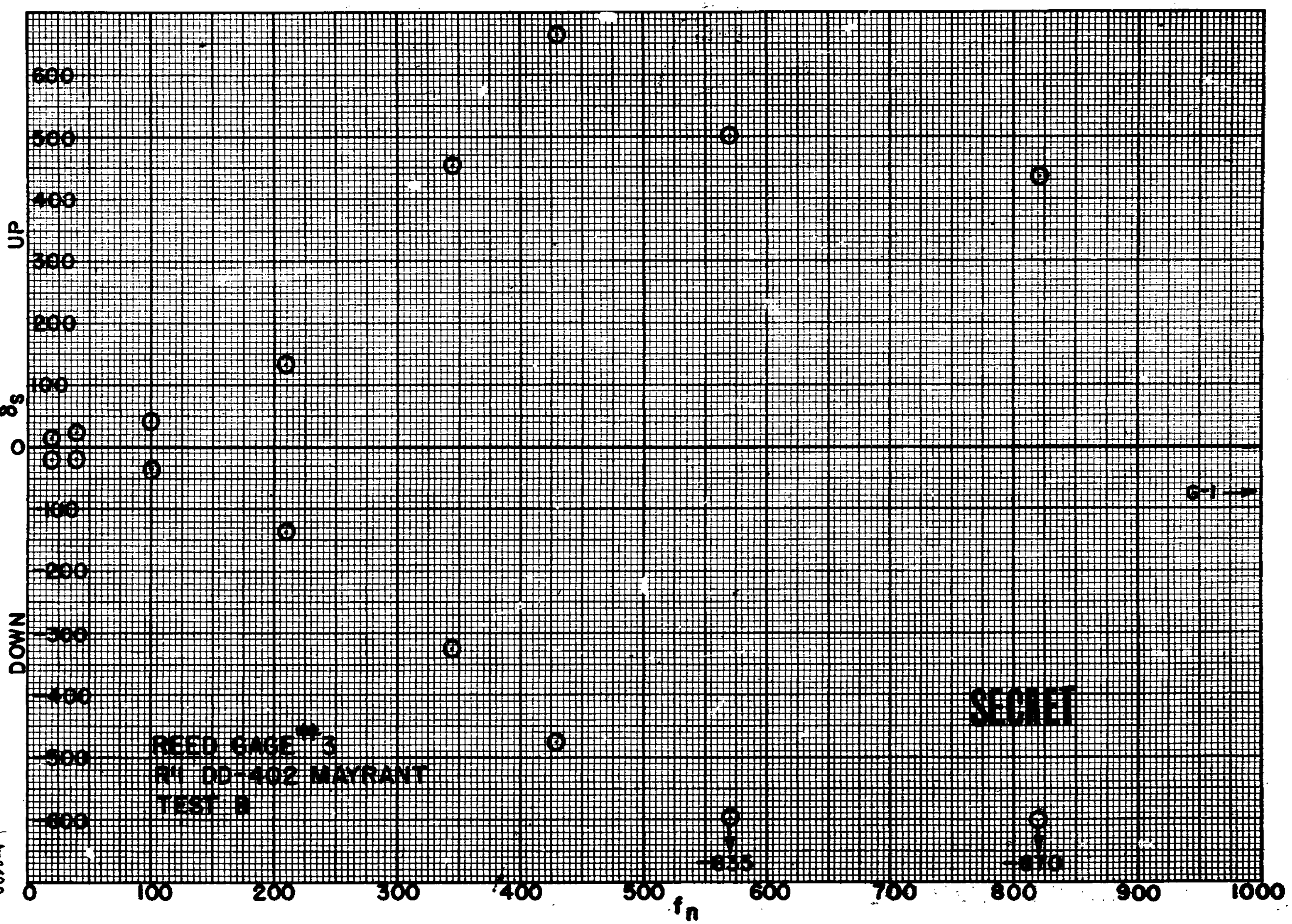
A-2609

COMMENTS

Test Baker   Range 2600 ft.   Bearing 353°

The instrumentation was planned for starboard exposure to the pressure waves, rather than the port bow.

In view of the high vertical putty gage acceleration of 300g. in the C.I.C. room, and the sizable deflections of R'1 on the hull, it is difficult to explain the low readings of the hull putty gages. D.S.M. reports a dishing of the starboard hull amidships, apparently due to the contact with tugs during decontamination, which makes the R'1 reading unreliable.



REED GAGE # 3
R1 DD-402 MAYRANT
TEST B
SECRET
UP
DOWN
$\frac{X}{\delta_s}$
f_n
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
0
100
200
300
400
500
600
700
800
900
1000
G-1

FIG. 12

A-2609

DD 403 TRIPPE
GAGE LOCATIONS

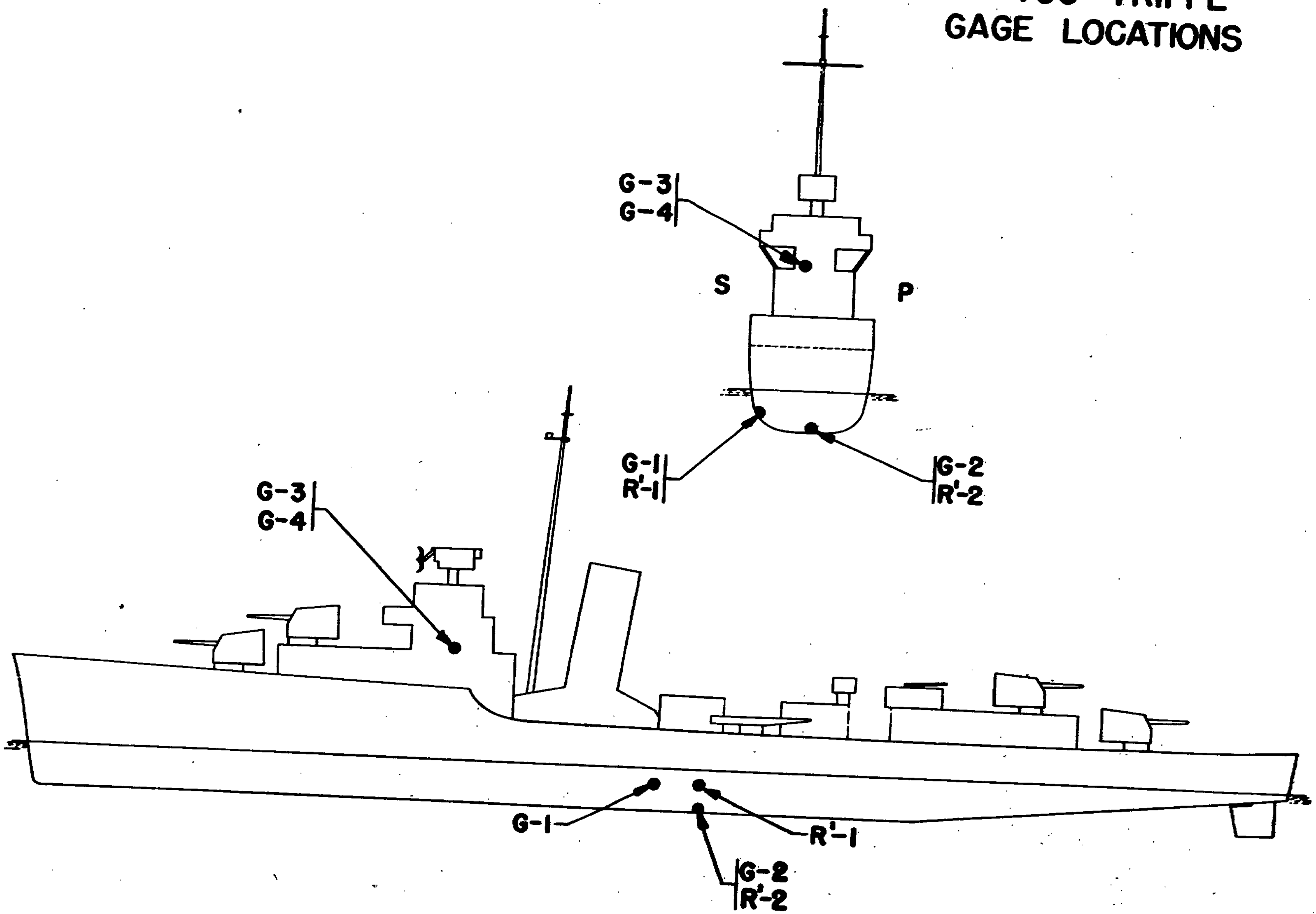


FIG. 13

A-2609

DD403 - USS TRIPPE

Putty Gages

G1 - Photo 262. In aft fireroom, compartment B-2-1. Directed inboard, normal on flange of starboard frame 97. 4 ft. below upper grating level.

A. Not installed B. Less than 50g.

G2 - Photo 263. In aft fireroom, compartment B-2-1. Directed up on top flange of keel. 56 in. forward of frame 104.5.

A. Not installed B. Unreadable

G3 - Similar to photo 292. In C.I.C. room. Directed up on deck at frame 62. 5 in. inboard from starboard bulkhead.

A. Not installed B. Less than 20g.

G4 - Similar to photo 272. In C.I.C. room. Directed to port on bracket on deck at frame 61. 7 in. inboard from starboard bulkhead.

A. Not installed B. Less than 20g.

Reed Gages

R'1 - Similar to photo 261. In aft fireroom, compartment B-2-1. Directed inboard, normal on flange of starboard frame 101. 4 ft. 6 in. below upper grating level.

A. Not installed B. Readings all zero

R'2 - Photo 263. In aft fireroom, compartment B-2-1. Directed up on top flange of keel, 66 in. forward of frame 104.5.

A. Not installed B. Unreadable

COMMENTS

Test Baker Range 4125 ft. Bearing 346°

The instrumentation was placed for starboard exposure to the pressure wave rather than the port bow.

All gages show no shock of intensity adequate to cause any readings. DSM reports no shock effects other than breakage of a few light bulbs.

DD 404 RHIND GAGE LOCATIONS

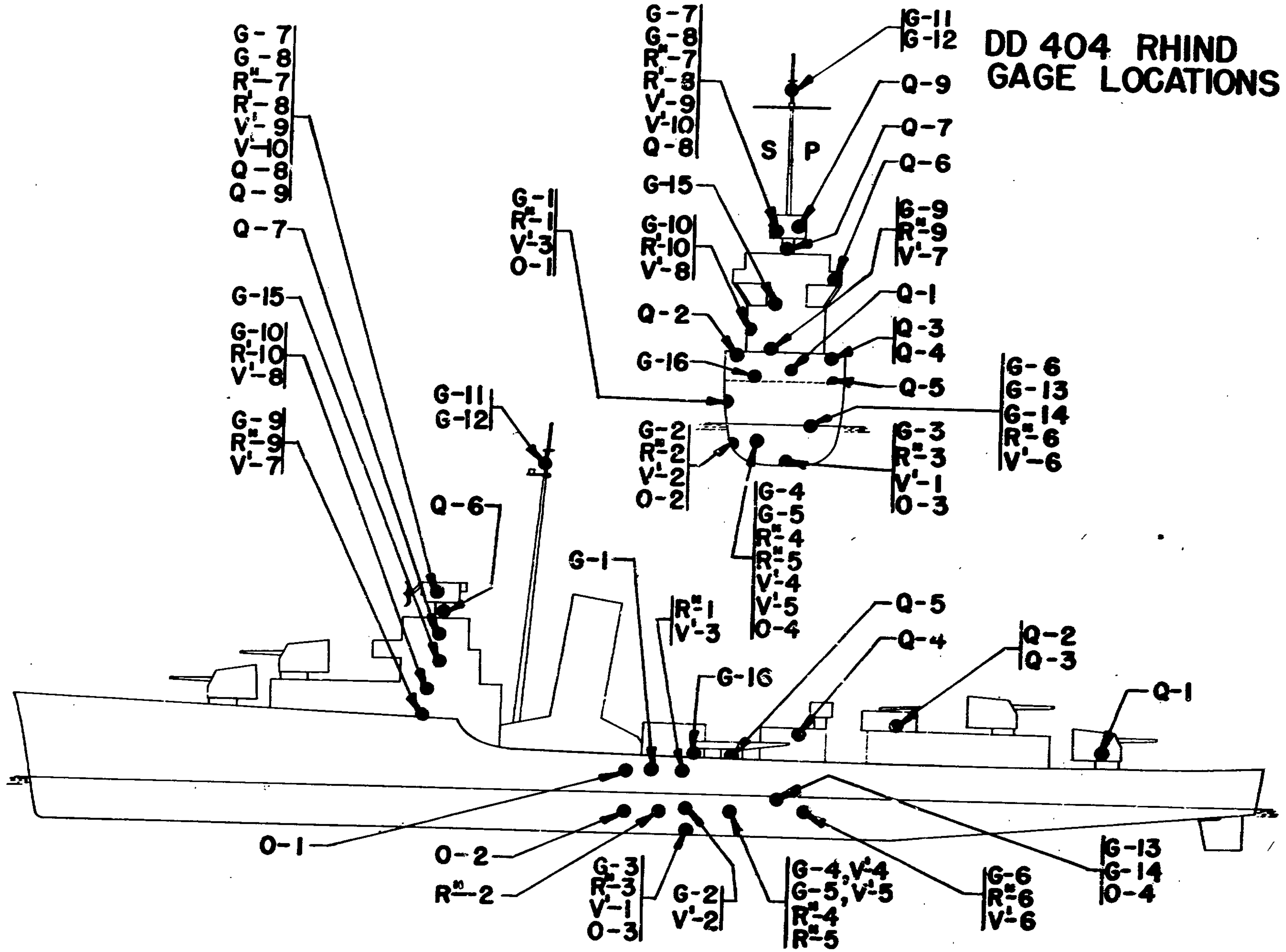


FIG. 14 A

A-2609

Putty Gages

G1 - Photo 263. In aft fireroom, compartment B-2-1. Directed inboard, normal on flange of starboard frame 97. About 5 ft. below main deck.

A. (1) 450g. B. 300g.

G2 - Photo 264. In aft fireroom, compartment B-2-1. Directed inboard, normal on flange of starboard frame 101. 4 ft. below upper grating level.

A. (3) less than 50g. B. Less than 50g.

G3 - Photo 263. In aft fireroom, compartment B-2-1. Directed up on flange of frame 101 about 6 in. to port of keel center line.

A. (3) less than 50g. B. Less than 50g.

G4 - Photo 266. In forward engine room, compartment B-3-1. Directed up on foundation of starboard low-pressure turbine, about 4 ft. below turbine shaft.

A. (3) less than 50g. B. Less than 50g.

G5 - Photo 266. In forward engine room, compartment B-3-1. Directed to port on foundation of starboard low-pressure turbine, about 4 ft. below turbine shaft.

A. (3) less than 50g. B. Less than 50g.

G6 - Photo 267. In forward engine room, compartment B-3-1. Directed up on top flange of short horizontal channel welded between two vertical stiffeners of bulkhead 118. The channel supports the forward end of the I-beam which passes under the starboard end of the main switchboard.

A. (3) less than 50g. B. Less than 50g.

G7 - Photo 268. In main battery director. Directed up on special bracket added on starboard vertical supports of director equipment. Just inside starboard door of director.

A. (2) 110g. B. Less than 20g.

DD404 - USS RHIND

Putty Gages

G8 - Photo 268. In main battery director. Directed to port on same bracket as G7.

A. (2) 100g. B. Less than 20g.

G9 - Photo 269. In Supply Office. Directed up on deck at frame 60, 12 in. from inboard bulkhead.

A. (3) less than 20g. B. Less than 20g.

G10 - Photo 270. In Supply Office. Directed to port on flange of vertical stiffener (frame 60) of starboard bulkhead. 3 ft. 6 in. above deck.

A. (1) 200g. B. 30g.

G11 - No photo. At top of main mast. Directed up on seat bracket about 3 ft. below top of mast.

A. Not recovered - Mast bent.

G12 - No photo. At top of main mast. Directed to port on starboard side of mast about 2 ft. below top of mast.

A. Not recovered - Mast bent.

G13 - Similar to photo 301. In forward engine room, compartment B-3-1. Directed up on port aft corner of inboard turbo-generator base at approx. frame 114. Base is on upper grating level.

A. (3) less than 50g. B. Less than 50g.

G14 - Similar to photo 301. In forward engine room, compartment B-3-1. Directed to port aft corner of inboard turbo-generator base at approx. frame 114. Base is on upper grating level.

A. (3) less than 50g. B. Over 300g.

G15 - Photo 271. In C.I.C. room. Directed to port on bracket on deck at frame 62. 5 in. inboard from starboard bulkhead.

A. (2) 125g. B. 50g.

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Putty Gages

G16 - Similar to photo 302. In Engineer's Record Office. Directed up on deck at frame 101. 8 in. inboard from starboard bulkhead.

A. (2) 70g. B. Less than 20g.

Reed Gages

R''1 - Photo 272. Slow speed. In aft fireroom, compartment B-2-1. Directed inboard, normal on flange of starboard frame 101, about 5 ft. below main deck.

Graph	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (1) Fig. 14 B Fig. 15	.595	.57	.45	.38
B wave 1 Fig. 23 Fig. 24	.03	.02	.02	.02
B wave 2 Fig. 23 Fig. 25	.025	.045	.01	.025

R''2 - Similar to photo 260. Slow speed. In aft fireroom compartment B-2-1. Directed to port, normal on flange of starboard frame 97. 56 in. below upper grating level.

Graph	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (3) Fig. 16 Fig. 17	.135	.175	.02	.05
B wave 1 p. Fig. 26 Fig. 27	.02	.02	.01	.01
B wave 2 p. Fig. 26 Fig. 28	.02	.025	.01	.02

R''3 - Photo 265. Slow speed. In aft fireroom, compartment B-2-1. Directed up on top flange of keel at frame 101.

Graph	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (3) Fig. 18 Fig. 19	.05	.02	.02	.015

B. Readings all zero

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Reed Gages

R''4 - Photo 266. High speed. In forward engine room, compartment B-3-1. Directed up on foundation of starboard low-pressure turbine. About 4 ft. below turbine shaft.

Graph Record	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (3) Readings all Zero.				
B. wave 1 Fig.29 Fig.30 Fig.31	.03	.03	.02	.01
B. wave 2 p. Fig.29 Fig.32	.02	.015	0	0

R''5 - Photo 266. High speed. In forward engine room, compartment B-3-1. Directed to port on starboard low-pressure turbine foundation near R''4.

Graph Record	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (3) Readings all zero.				
B. wave 1 Fig.33 Fig.34	.02	.01	.005	.005
B. wave 2 Fig. 33 Fig.35	.02	.015	.01	.01

R''6 - Photo 267. High speed. In forward engine room, compartment B-3-1. Directed down on underside of fore-and-aft I-beam under starboard end of main switchboard. Gage is at upper grating level about 30'' forw[illegible]d of bulkhead 118.

Graph Record	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (3) Readings all zero.				
B. wave 1 Fig.36 Fig.37 Fig. 38	.05	.06	.02	.02
B. wave 2 Fig. 36 Fig.39	.025	.035	.02	.02

DD404 - USS RHIND

Reed Gages

R''7 - Photo 273. Slow speed. In main battery director directed up on special bracket added on starboard supports of director equipment. Just inside starboard door of director.

Graph Record	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (2) Readings all zero.				
B. wave 1 Fig. 4 Fig.41	.02	.04	.02	.02
B. wave 2 Fig.4 Fig.42	.035	.05	.02	0

R''8 - Photo 273. In main battery director. Directed to port on same bracket as R''7.

A. Unreadable

B. Record lost

R''d - Photo 274. In Supply Office. Directed up on deck at frame 60, 30 in. from inboard bulkhead.

Graph Record	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (3) Fig. 20 Fig. 21	.03	.08	.025	.07
B. wave 1 Fig. 43 Fig.44	.035	.035	.02	.02
B. wave 2 Fig.43 Fig.45	.02	.02	.01	.01

R'10 - Photo 275. In Supply Office. Directed to port on flange of vertical stiffener (frame 63) of starboard bulkhead. About 3 ft. above deck.

Graph Record	20 cps Up	20 cps Dn	40 cps Up	40 cps Dn
A. (1) Fig. 22	1.35	1.59	.57	.715
B. Figure 46	.11	.125	.27	.27

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Indenter Gages

Q1 - Similar to photo 306. In aft (No. 4) 5" gun turret. Directed up on deck frame member on starboard edge of breech clearance depression about 2 ft. forward of starboard support of gun. Directions assume gun to be pointed aft.

A		B	
Up	0g.	Up	35g.
Dn	55	Dn	60
25°	48	15°	40
115°	70	105°	25
205°	112	195°	25
295°	22	285°	50

Q2 - Photo 276. On starboard 40 mm gun platform at approximately frame 135. Directed up on deck over the intersection of two beams under the platform. To starboard and aft of gun pedestal.

A		B	
Up	60g.	Up	85g.
Dn	140	Dn	40
40°	150	80°	90
130°	90	170°	70
220°	170	260°	75
310°	85	350°	80

Q3 - Photo 277. On port 40 mm gun platform at approximately frame 135. Directed up on deck at location summetrical about ship centerline with Q2 location.

A		B	
Up	125g.	Up	160g.
Dn	140	Dn	50
19°	725	15°	235
100°	295	105°	70
190°	370	195°	430
280°	160	285°	70

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Indenter Gages

Q4 - Photo 278. On port mark 51, 40 mm gun director platform. Directed down at intersection of beams on underside of platform. Director pedestal is over center of rectangle formed by beams on underside of platform; gage is at forward starboard corner of this rectangle.

A		B	
Up	50g.	Up	40g.
Dn	70	Dn	80
45°	55	70°	35
135°	50	160°	25
225°	120	250°	30
315°	80	340°	30

Q5 - Photo 279. On main deck about 6" outboard from base of port torpedo tubes. Directed up over main frame member of approx. frame 112.

A		B	
Up	0g.	Up	50g.
Dn	60	Dn	20
30°	50	0°	40
120°	80	90°	20
210°	80	180°	15
300°	50	270°	50

Q6 - Photo 280. At base of port torpedo director on navigation bridge deck. Directed up on deck to starboard and aft of director pedestal over intersection deck reinforcing members.

A		B	
Up	105g.	Up	70g.
Dn	110	Dn	90
5°	170	0°	20
95°	100	90°	35
185°	200	180°	0
275°	130	270°	70

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Indenter Gages

Q7 - Photo 281. On pedestal of main 5 in. gun director. Directed aft and up on flange of aft brace of the support tube, 2 in. above top of pilot house.

A				B			
brg.	0° elev.	-20°	85g.	brg.	0° elev.	-20°	30g.
"	71° "	42°	517	"	71° "	42°	90
"	109° "	-42°	331	"	109° "	-42°	48
"	180° "	20°	112	"	180° "	20°	50
"	251° "	-42°	375	"	251° "	-42°	95
"	289° "	42°	712	"	289° "	42°	48

Q8 - Photo 268. Inside main 5 in. gun director turret. Directed up on same bracket as G7 etc.

A		B	
Up	165g.	Up	50g.
Dn	170	Dn	30
70°	520	75°	20
160°	490	165°	30
250°	400	255°	30
340°	550	345°	30

Q9 - Photo 282. Inside main 5 in. gun director. Directed up on 3 in. x 3 in. x 1/8 in. channel which runs forward from forward port corner of the internal director mechanism shell, 30 in. above platform which is just inside port door of director.

A		B	
Up	280g.	Up	180g.
Dn	260	Dn	175
45°	270	45°	310
135°	425	135°	200
225°	345	225°	160
315°	440	315°	125

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Shock Displacement Gages

01 - Photo 283. In aft fireroom, compartment B-2-1. Directed to port on flange of starboard shell frame 93. 3 ft. below main deck.

B. Record not reproduced but is available.

02 - Photo 284. In aft fireroom compartment B-2-1. Directed to port on flange of starboard shell frame 93. 4 ft. below upper grating level.

B. Record not reproduced but is available.

03. Photo 285. In aft fire room compartment B-2-1. Directed up on flange of port frame 101 near keel.

B. Record not reproduced but is available.

04 - Photo 286. In forward engine room, compartment B-3-1. Directed up on starboard aft corner of base of starboard turbo-generator at approx. frame 114. Base is at upper grating level.

B. Record not reproduced but is available.

Velocity Meters

V'1 - Photo 287. In aft fireroom, compartment B-2-1. On starboard frame 101, 5 ft. below main deck. Directed to port. Note: Travel to base stop is 1" ± 1/32".

A. (1) Record not distinguishable

B. Record not distinguishable.

V'2 - Photo 264. Aft fireroom, compartment B-2-1. Directed to port on starboard frame 101, below upper grating level. Note: Travel to base stop is 1 1/8" ± 1/32".

A. (3) Record not distinguisable.

B. Record not distinguishable.

DD404 - USS RHIND

Velocity Meters

V'3 - Photo 272. Aft fireroom compartment B-2-1. Directed up on frame 101, about 1 ft. to starboard of keel centerline.

A. (3) Record not distinguishable.

B. Record not distinguishable.

V'4 - Photo 266. Forward engine room, B-3-1. Directed up on starboard low pressure turbine foundation, about 4 ft. below turbine shaft. Note: Travel to base stop is 1 1/16" ± 1/32".

A. (3) Record not distinguishable.

B. Record not distinguishable.

V'5 - Photo 288. Forward engine room, compartment B-3-1. Directed to starboard on starboard low pressure turbine foundation, about 4 ft. below turbine shaft. Note: Travel to base stop is 1" ± 1/32".

A. (3) Record not distinguishable.

B. Record not distinguishable.

V'6 - Photo 289. Forward engine room, compartment B-3-1. Directed down on under side of beam under starboard end of main switchboard, 20" forward of bulkhead 118.

A. (3) Record not distinguishable.

B. Record not distinguishable.

V'7 - Photo 269. Supply Office. Directed up on deck over beam at frame 60, 12" from inboard bulkhead. Note: Travel to base stop is 1" ± 1/32".

A. (3) Record not distinguishable.

B. Fig. 48, Channel 7.

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Velocity Meters

V'8 - Photo 270. Supply Office. Directed to port on starboard bulkhead frame 61, about 3 ft. above deck. Note: Travel to base stop is 1" ± 1/32".

A. (1) Fig. 47, Channel 8.

B. Fig. 47, Channel 8.

V'9 - Photo 290. Main battery director. Directed up on gage bracket just inside starboard door. Note: Travel to base stop is 1" ± 1/32".

A. (2) Record not distinguishable.

B. Record not distinguishable.

V'10 - Photo 290. Main gun director. Directed to port on gage bracket just inside starboard door.

A. (2) Fig. 47, Channel 10.

B. Fig. 48, Channel 10.

COMMENTS

Test Able   Range 3038 ft.   Bearing 61°

Putty gages G1, G7, G8, G10, G15 and G16 were the only gages to show any reading. All these were on or very close to bulkheads or structures acted upon directly by the pressure wave. In fact all these structures were dished severely by the pressure. Note that G2 which was about 5 ft. below the waterline was unaffected while G1, 5' above the waterline, read 450g.

Reed gages R''1 and R'10 had high readings in accord with the putty gages adjacent to them. Both show a long duration shock as indicated by their frequency response curves. R'10 was on the Supply Office bulkhead which was ruptured and dished several inches, and indicates an "equivalent shock duration" of 20 milliseconds. R''1 indicates an equivalent duration of 10 and/or 2 milliseconds. The difference in response frequency is tentatively attributed to difference in natural frequency of the structures on which the gages were mounted.

The indenter gage readings are fairly consistent with the other gage readings. Q1, Q2, Q4, and Q5 all had rather low readings apparently because they were tied in closely with heavy rigid mounting bases rather than the light structures with extensive exposed areas which produced large putty and reed gage readings. Q3 at the port side location corresponding to Q4 on the starboard side read high for reasons not apparent. Q6 gave a reasonable reading; Q7 seems rather high. Q8 was adjacent to G7 and G8 and read 50% and 500% higher than these putty gages for the same directions.

Velocity meters V'8 and V'10 indicate shocks in agreement with the similarly placed reed gages and putty gages. V'8 records a velocity change of about 18 ft./sec. in an interval of 10 milliseconds at time equal to .165. In this interval the greatest slope corresponds to about 110g. as compared with 200g. recorded by G8 at the same location. A transient vibration of about 70 cps is discernable. R'10 at this location indicated a disturbance of about 100 cps. The V'10 record is of a quite different nature, presumably because the gage location was not closely connected with exterior surfaces. Interpretation of this wave is difficult since the sudden velocity changes at .12 and .15 seconds are probably due to bottoming of the gage. The rise from .075 to .12 seconds is gradual and corresponds roughly to the natural vibration frequency of the spring supported mass of the velocity meter. Since the adjacent putty gage read 100g., it is concluded that the velocity change produced by the 100g. acceleration was not large enough to be apparent on the velocity meter record.

In summary, 500g. seems to be a fair estimate of the acceleration of structures having a high ratio of directly exposed area to resistance to motion (i.e. mass or rigid connection to massive unexposed members). Locations immediately adjacent to the above but not close to very heavy members registers about 100-200g. Examples of these latter locations are within the gun director, within the Engineer's Record Office, on the deck of C.I.C., etc. Heavy masses such as the 5" guns and the torpedo tube base undergo accelerations less than 100g. and structure over, say, 5 ft. away from the exposed surfaces show accelerations under 100g. even without benefit of adjacent massive items.

Test Baker Range 6825 ft. Bearing 318°

The instrumentation was planned for direct exposure of the starboard side to the shock waves, while the port bow was actually closest to the explosion.

The only putty gages to show readings were G1, G10, G14, and G15 of which only G1 and G14 were of significant magnitude. Since the indentations of G14 were very small and a zero reading is indicated by the location and the readings of the other gages, it is considered that the G14 reading should be ignored. The G1 reading also is questionable since the identical location on the DD408 showed no reading and its location was very likely to be struck by a tug or small boat.

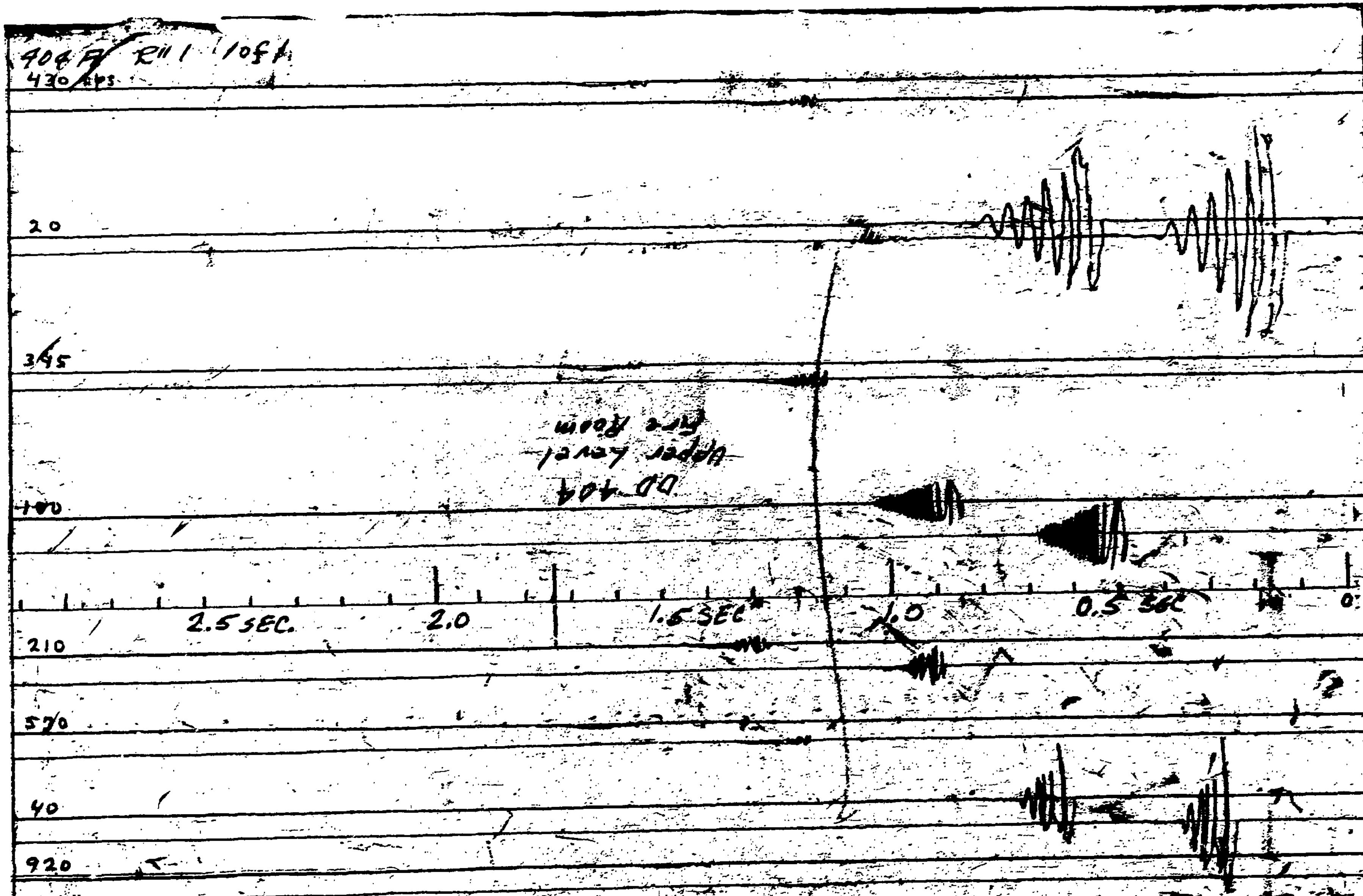
All the reed gages showed negligible shock. The motorized gages recorded the underwater and airblast shocks separately on the time scale. The motorized reed gages show a trend which is supported by the velocity meters and other gages in that the keel and hull gages suffered less shock due to the underwater pressure than those in the superstructure. This is a contradiction to the generally accepted rule that the shock in the hull us greater than that above the waterline. This will be discussed in the comments on the destroyers as a class.

While the motorized reed gage records do not permit definite separation of the successive pulses prior to the airblast, they show excitation by these pulses up to 1.3 seconds after the initial excitation. The major pulses are usually apparent however.

V'7, V'8, and V'10 were the only meters to show readings above the background. V'7 and V'10 record low and apparently reliable indications of the successive underwater pressure waves. V'8 shows one definite pulse and vibration probably at the bulkhead natural frequency but it is not certain whether this is due to air or water pressure. Note that these gages were in the superstructure.

Q3 and Q9 were the only indenter gages which recorded a shock. It may be significant that both were on the port side. Q9 is within the gun director and yields a higher reading than the putty gages and the indenter gage on the starboard side of the director or the indenter gage at the base of the director. This suggests that its reading and probably that of Q9 were caused by the airborne pressure wave.

While the shock recorded was low, data was obtained on the variation in shock with location in the ship. Both air and water pressure produced readings but the distribution of the waterborne shock is thus far anamalous.



DD 404 TEST ABLE, R11 FIG.

A-2609

Defense Special Weapons Agency
6801 Telegraph Road
Alexandria, Virginia 22310-3398

TRC

18 April 1997

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OMI/Mr. William Bush (Security)

SUBJECT: Declassification of Reports

The Defense Special Weapons Agency has declassified the following reports:

AD-366588	XRD-203-Section 12
AD-366589	XRD-200-Section 9
AD-366590	XRD-204-Section 13
AD-366591	XRD-183
AD-366586	XRD-201-Section 10
AD-367487	XRD-131-Volume 2
AD-367516	XRD-143
AD-367493	XRD-142
AD-801410L	XRD-138
AD-376831L	XRD-83
AD-366759	XRD-80
AD-376830L	XRD-79
AD-376828L	XRD-76
AD-367464	XRD-106
AD-801404L	XRD-105-Volume 1
AD-367459	XRD-100

TRC

18 April 1997

Subject: Declassification of Reports

AD-801406L ✓ XRD-114✓

In addition, all of the cited reports are now **approved for public release; distribution statement "A" now applies.**

Ardith Jarrett

ARDITH JARRETT

Chief, Technical Resource Center